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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

MINERAL RESOURCES

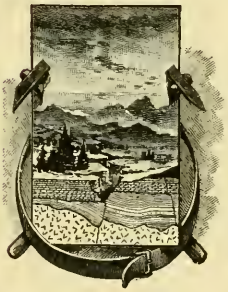
OF THE

UNITED STATES

CALENDAR YEAR

1912

PART I—METALS



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MINERAL RESOURCES OF THE UNITED STATES IN 1912—PART I.

MINERAL PRODUCTS OF THE UNITED STATES: REVIEW OF CONDITIONS AND OUTPUT IN 1911 AND 1912.

By Edward W. Parker.

INTRODUCTION.

The present report on the mineral resources of the United States, which covers the calendar year 1912, completes the third decade of the work of the division of mineral resources, first authorized in 1882 by a provision added to the general appropriation to the Geological Survey to the effect that "not to exceed ten thousand dollars of the amount appropriated in this paragraph may be applied under the direction of the Secretary of the Interior to the procuring of statistics in relation to mines and mining other than gold and silver and in making chemical analyses of iron, coal, and oil." With the small appropriation available at that time it was possible to include in the reports only statistical estimates prepared by experts on the several subjects, with more or less extended reviews of market conditions and some special contributions on mining localities, mining methods, and technical progress. This method prevailed during the first two decades following the organization of the work. During this period, however, the work in the division of geology had developed geologists in the Survey who specialized along certain lines and for the last 10 years the reports on the several mineral resources have been prepared by the specialists so developed. This change has been with the view of carrying out the provision of the organic act of the Survey which directs it to classify the public lands and to examine the geologic structure, mineral resources, and products of the national domain.

The statistical treatment has now been developed to a high degree of exactitude, and the statements of production, consumption, etc., presented in these volumes are the results of an annual census of the entire mining industry. An instance of the more comprehensive study of the sources of mineral wealth is presented in the report on the production of iron ores, pig iron, and steel in 1908, which con-

tains maps and brief descriptions of the iron-producing fields and the localities of the blast furnaces. A map showing the geographic distribution of the sources of precious and semiprecious metals in the Western States was published in 1907. The report on the production of coal in 1910 contains maps of the several coal areas of the United States. Maps have also been published showing the oil and gas fields and the cement localities. In the report for 1911 the distribution of the quarry industries in the Eastern States was shown by map illustrations, and similar maps showing the quarrying localities in the Central States are published in the present report. This manner of presentation of the mineral resources of the United States will be extended to the clay-working and other branches of the mining industry as rapidly as the facilities available will permit, for it is recognized that in no other branch of the mining industry is the economic and sociologic progress of the country better illustrated than in the development of those products which are used in the construction of buildings and in civic improvements. In this way the statistics have been and will continue to be complemented by the studies of the sources of the mineral production and the application of the products to the useful arts. The volumes have grown into a cyclopedia of information on the mineral resources of the United States. An accurate knowledge of nature's storehouses from which future supplies are to be drawn is recognized as of paramount importance. To obtain this knowledge, as well as to record the history of past achievement, is the purpose and aim of the division of mineral resources.

COOPERATION WITH STATE GEOLOGICAL SURVEYS.

In the preparation of the present report, as of those for 1910 and 1911, the United States Geological Survey has had the active cooperation of most of the State geological surveys.[1] The statistics so obtained have been used jointly by the State and Federal surveys, and the results have been checked before publication. The objects attained by cooperative agreement are four in number:

1. The avoidance of annoyance to the producers in the form of duplicate requests for the same statistical information.
2. The procuring of prompter and more complete returns.
3. The enabling of the State geologists to keep in touch with the producers and with new developments in their respective jurisdictions.
4. The avoidance of two divergent sets of statistics covering the same field and each bearing an official stamp, the existence of which is necessarily confusing to a student of the subject and tends to discredit one statement or the other, if not both.

Special acknowledgment is made of the assistance received by the United States Geological Survey from the directors of the State surveys; the cooperative arrangement has been carried out in a harmonious manner and with exceedingly gratifying results.

The officials who cooperated with the United States Geological Survey in 1912 are as follows:

[1] The statistics relating to the production of gold, silver, copper, lead, zinc, and quicksilver are excepted from this cooperation.

Alabama	Dr. Eugene A. Smith, State geologist, University.
Georgia	Dr. S. W. McCallie, State geologist, Atlanta.
Illinois	Mr. Frank W. De Wolf, director, Urbana.
Iowa	Mr. George F. Kay, director, Iowa City.
Kansas	Dr. Erasmus Haworth, State geologist, Lawrence.
Maryland	Dr. William B. Clark, State geologist, Baltimore.
Michigan	Mr. R. C. Allen, director, Lansing.
Missouri	Dr. H. A. Buehler, director, Rolla.
New Jersey	Dr. Henry B. Kümmel, State geologist, Trenton.
North Carolina	Dr. Joseph Hyde Pratt, State geologist, Chapel Hill.
Oklahoma	Mr. D. W. Ohern, director, Norman.
Oregon	Prof. H. M. Parks, director, Corvallis.
Pennsylvania	Mr. Richard R. Hice, State geologist, Beaver.
Texas	Dr. William B. Phillips, director, Austin.
Virginia	Dr. Thomas L. Watson, director, Charlottesville.
Washington	Mr. Henry Landes, State geologist, Seattle.
Wisconsin	Mr. W. O. Hotchkiss, State geologist, Madison.

ORGANIZATION.

The division of mineral resources which compiles this series of reports is divided into two sections, namely, "metals" and "nonmetals." The annual report is published in two volumes, Part I being devoted exclusively to metals and Part II to fuels, structural materials, chemical minerals, and other nonmetallic products. Since 1907, when, at his own request, David T. Day was relieved as chief of division, the administration of the division of mineral resources has been under Edward W. Parker, statistician in charge. During the year in which the preparation of the present report has been in progress the section of metals has been under the administrative charge of H. D. McCaskey, vice Waldemar Lindgren, resigned, and the administration of the section of nonmetals has been conducted by the statistician in charge of the division. For the purpose, primarily, of facilitating the collection of statistics of the precious metals in the Western States and of providing convenient places for consulting the publications of the United States Geological Survey by the mining fraternity in the Rocky Mountain and Pacific Coast States, offices are maintained in Denver, Colo., Salt Lake City, Utah, and San Francisco, Cal., Mr. McCaskey having general supervision of the western offices. The division of mineral resources works in close cooperation with the division of geology, and most of the chapters and subchapters of the annual volumes are prepared by geologists who have specialized in the subjects treated by them. The advantage of having the services of these specialists, who are familiar with the occurrence, treatment, and uses of the several mineral substances, is well recognized and has aided materially in maintaining the standard, broadening the scope, and increasing the usefulness of the reports. The chapters comprising the present report have been contributed by the following specialists:

General:

Edward W. Parker—Review of conditions in 1911 and 1912.

William T. Thom—Summary of mineral production.

In the section of metals:

H. D. McCaskey (in charge of section)—General report on gold and silver; precious and semiprecious metals in Eastern States (mines report); general supervision of reports on precious and semiprecious metals in Western States (mines report); quicksilver.

Ernest F. Burchard—Iron ore, pig iron, and steel; manganese and manganiferous ores.

B. S. Butler—General report on copper; mines report on silver and copper in Michigan.
C. E. Siebenthal—General reports on lead, zinc, and cadmium.
W. C. Phalen—Bauxite and aluminum.
Frank L. Hess—Tin; arsenic; antimony; bismuth; selenium; tungsten; vanadium; uranium; nickel; cobalt; titanium; tantalum; molybdenum.
David T. Day—Platinum.
J. S. Diller—Chromic iron ore.
John P. Dunlop—Precious and semiprecious metals in Central States, except Michigan (mines report); metals and metallic ores (summary); statistics of recovery of secondary metals, published as a press bulletin and included in various reports of the primary metals.
Alfred H. Brooks—Precious and semiprecious metals in Alaska (mines report).
Charles W. Henderson (in charge of Denver office)—Precious and semiprecious metals in Colorado, New Mexico, South Dakota, Wyoming, and Texas (mines report).
Charles G. Yale (in charge of San Francisco office—Precious and semiprecious metals in California and Oregon (mines report).
Victor C. Heikes (in charge of Salt Lake City office)—Precious and semiprecious metals in Arizona, Utah, Nevada, and Montana (mines report).
Clarence N. Gerry (assistant to Victor C. Heikes)—Precious and semiprecious metals in Idaho and Washington (mines report).

In the section of nonmetals:

Edward W. Parker—Coal; coke; briquetting of fuels; gas, coke, tar, and ammonia.
David T. Day—Petroleum; asphalt, bituminous rock, and related bitumens.
David T. Day and B. Hill—Natural gas.
Charles A. Davis—Peat.
Ernest F. Burchard—Stone; cement; fluorspar and cryolite.
Jefferson Middleton—Clay-working industries; sand-lime brick; fuller's earth.
J. H. Hance—Notes on the occurrence of varieties of clay.
Ralph W. Stone—Gypsum; sand and gravel; lime.
A. T. Coons—Slate.
J. S. Diller—Asbestos; talc and soapstone.
W. C. Phalen—Phosphate rock; salt and bromine; potash salts; sulphur, pyrite, and sulphuric acid.
Frank J. Katz—Abrasive materials; quartz and feldspar.
James M. Hill—Mineral paints; barytes and strontium.
Douglas B. Sterrett—Gems and precious stones; mica; monazite.
E. S. Bastin—Graphite.
Charles G. Yale and Hoyt S. Gale—Borax; magnesite.
George C. Matson—Mineral waters.

The writer desires to express his high appreciation of the enthusiastic support and cooperation rendered by his associates in the preparation of this report, and in no less degree to acknowledge the efficient, loyal, and conscientious cooperation of the clerical and stenographic members of the division who have borne the brunt of the work in collecting the figures, scutinizing and editing the schedules, and compiling the tables, a number of them doing double duty as stenographers and statistical clerks. In the following list only the special duties assigned to the clerical force are mentioned as it is in the performance of these duties that particular recognition is earned.

Miss Belle Worth Bagley, statistical clerk—Clay-working industries.
Miss Elizabeth A. Balloch, stenographer—General correspondence and special correspondence relative to coal.
Mrs. Helen L. Bennit, stenographer and statistical clerk—Coke; talc and soapstone; asbestos; mineral waters; graphite; chromic iron ore; quartz and feldspar; and correspondence relative thereto.
Miss Martha B. Clark, statistical clerk and stenographer—Mineral products; aluminum, bauxite, and aluminum salts; abrasive materials; iron ore; pig iron; manganese and manganiferous ores; sulphur, pyrite, and sulphuric acid; ferro-alloys; and correspondence relative thereto.
Miss Altha T. Coons, statistical clerk—Stone; lime; salt and bromine; slate.

Miss Julia M. Corse, stenographer and statistical clerk—Briquets; general correspondence; distribution of publications.
Miss Belle Hill, statistical clerk—Natural gas.
Miss Lucy Marshall Jones, statistical clerk and translator—Barytes and strontium; fluorspar and cryolite; fuller's earth; gypsum; mineral paints; phosphate rock; and correspondence relative thereto. Correspondence relative to cooperation with State surveys.
Miss Lida Mann, statistical clerk—Coal.
Miss Anne B. Coons, statistical clerk—Petroleum.
Mrs. L. L. Kimball, statistical clerk—Cement; sand and gravel.
Miss Katrine W. Cottrell, statistical clerk—Sand-lime brick.
Miss M. L. Clark, stenographer and statistical clerk—Semiprecious metals and rare metals.
Miss Bessie B. Borst, stenographer and file clerk—Statistical work in connection with gems and precious stones, mica, monazite, and zircon.
Mrs. Winifrede Cunningham, stenographer—General correspondence.
Miss Helen M. Hough, statistical clerk—Small coal mines.
Miss Elizabeth H. Burroughs, statistical clerk—Gas, coke, tar, and ammonia.
Mrs. Julia W. Wellborn, clerk—Clipping of newspapers and technical magazines.
Miss Frances F. Crossman, stenographer—General correspondence.
Miss Blanche H. Stoddard, stenographer—General correspondence.
Miss Florence Begeman, stenographer—Assigned to special work for Mr. McCaskey.
Miss Cecil Murray, stenographer and statistical clerk—Correspondence on stone and other subjects.
Mr. Glenn J. Hirst, statistical clerk—Precious and semiprecious metals (Salt Lake City office).
Mrs. Virginia E. Knowles, statistician—Precious and semiprecious metals (Denver office).
Mrs. Bessie Patchell, stenographer and statistical clerk—Precious and semiprecious metals (Salt Lake City office).
Miss Daisy Walker, stenographer and statistical clerk—Precious and semiprecious metals (San Francisco office).

HISTORICAL REVIEW.

In the present report, as in the preceding reports of the series, the mineral production is treated primarily by subjects. For detailed discussion of the occurrence and production by States of each mineral substance the reader should consult the chapters by subjects in the two volumes of this report. The statistics of production include comparisons with earlier years, the figures for which are carried forward each year for convenient reference. The earlier volumes, beginning with that of 1882, the first of the series, should be consulted for other notes on occurrence, development, trade conditions, and uses, descriptions of mining districts, and other information of a technical character which it is impracticable to carry forward from year to year. The two volumes comprising the report Mineral Resources of the United States, 1912, begin the fourth decade during which the statistics of mineral production in the United States have been recorded by the Geological Survey. In the 31 years from 1882 to 1912, inclusive, the value of the mineral products of the country has increased form $451,901,159 to $2,243,630,326. In 1880, according to the Tenth Census, the value of the mineral production was $364,928,298. The population of the United States in that year numbered 50,189,209 persons, so that the value of the output of the mines represented an average of $7.27 for each inhabitant. At the taking of the Thirteenth Census in 1910 the population of the country had increased to 91,972,266 persons. The value of the mineral production in 1910 was $1,992,405,727, or an average of $21.66 for each inhabitant.

It is estimated that the population of the United States in 1912 numbered approximately 95,610,000 persons, an increase of about 3,638,000 over 1910, and of 45,421,000 over 1880. The value of the production in 1912 represented an average of $23.47 for each inhabitant. From 1880 to 1912 the population of the United States has not quite doubled (the increase being a little over 90 per cent), while the value of the mineral production in 1912 was over six times that of the earlier year. In other words, the per capita mineral production in 1912, as expressed in the value of the output, was more than three times what it was in 1880. In the review of the mineral production of the United States in the preceding volume of this series it was stated that the most striking increases which have been made during the three decades covered by these reports have been in the production of iron, copper, and gold for the metals, and in the fuels (coal, petroleum, and natural gas) and cement for the nonmetals. These features are accentuated in the statistics of production covering 1912. The value of the pig-iron product, including that made from foreign ores, has increased from $106,336,429 in 1882 to $420,563,388 in 1912 (marketed production), the value of the output in the latter year being nearly four times that of 1882.[1] The value of the copper production in 1912, $205,139,338, was nearly 13 times that of 1882 ($16,038,091), and the gold production, valued at $93,451,500 in 1912, was nearly three times the $32,500,000 produced in 1882. The value of the silver production in 1912 was less than that of 1882 by nearly $2,000,000, notwithstanding an increase of over 75 per cent in the quantity produced, advances in metallurgy having lessened the cost and increased the output, so that the price of silver, not having a fixed value like gold, is only slightly more than half what it was 30 years ago. The production of lead has increased from 132,890 short tons, valued at $12,624,550, in 1882 to 415,395 tons, valued at $37,385,550, in 1912, while the output of zinc has increased from 33,765 short tons, valued at $3,646,620, to 323,907 tons, valued at $44,699,166.

The combined value of the anthracite and bituminous coal production of 1912 was $695,606,071, or 4.7 times the $146,632,581 covering the output of 1882. The value of the petroleum production was $24,065,988 in 1882, and in 1912 it was $163,802,334, 6.8 times that of the output of 1882. Natural gas as a mineral product had just arrived in 1882, with a reported value of $215,000. In 1912 the production was valued at $84,563,957. After natural gas the production of cement has shown the greatest percentage of increase, as in 1882 that branch of the mineral industry was in its infancy. The product in that year was valued at $3,672,750. In 1912 the marketed product was valued at $69,554,385. In 1882 by far the largest part of the cement manufactured in the United States was natural cement, the output of that grade being 3,165,000 barrels. The quantity of Portland cement made in the United States in 1882 was 85,000 barrels. In 1912, 82,438,096 barrels of Portland cement, or nearly 1,000 times the output of 1882, were made. The manufacture of natural cement has, on the other hand, fallen into decadence. It reached its maximum production of 9,868,179 barrels in 1899. In 1912 it was less than 10 per cent of that quantity, with a total of 821,231 barrels

[1] The value of the pig iron made exclusively from domestic ores in 1912 was $402,378,453. See chapter on production of iron ore, pig iron, and steel.

marketed. Still more striking illustrations of the growth of the mining industry in the United States in the three decades under review are afforded by the facts that while in 1880 the total mineral production of the United States was valued at $364,928,298, in 1912 the value of the pig iron alone was $420,563,388, or over 15 per cent more than the entire mineral production in the United States at the taking of the Tenth Census, and that the combined value of the anthracite and bituminous coal produced in 1912 ($695,606,071) exceeded by 90 per cent the total value of all the mineral products of the United States in 1880. In the earlier year the value of the mineral products was approximately $1,000,000 per day. In 1912 it was about $6,147,000 per day. Of the total value of the mineral output of the United States, metals constitute more than one-third and nonmetals less than two-thirds. The metallic products in 1912 were valued at $867,103,085; the nonmetallic products at $1,376,027,241. The largest quantity and the greatest value of all the minerals produced are represented by the output of the coal mines. The production of coal in 1912 amounted to 534,466,580 short tons, valued at $695,606,071. Second in the total value of the production and first among the metals is pig iron, the marketed output in 1912 being 30,180,969 long tons, valued at $420,563,388. The value of the coal production represented 31 per cent of the total mineral output in 1912; and that of pig iron 19 per cent.

RAW AND DERIVED PRODUCTS.

In compiling the statistics of mineral production the value of the metallic products is fixed upon the refined or partly refined metals, and is of course much greater than the value of the ores from which they are obtained. During recent years the statistics of pig-iron production have been supplemented by accurate determinations of the quantity of iron ore produced and the value thereof, but the quantity and value of the pig iron have been maintained as the units of output. The ores of the precious and semiprecious metals are commonly complex mixtures of several metals, and no quantities or values can be expressed until the contents are extracted in metallic form and become articles of commerce. Chromic iron ore, manganese ore, manganiferous ores, and bauxite (aluminum ore) are marketed as such. In the nonmetals the quantities are expressed and the value placed upon the products in the condition in which they are first sold. With the fuels, with phosphate rock, and with some of the other nonmetals the quantities and values represent the raw product. With cement, however, there is no commercial product until the material is in the finished state as cement. The clay products appear as finished brick, terra cotta, tile, porcelain, pottery, etc., with the exception of a small quantity of special clays sold raw. The quarry products are sold rough, partly dressed, and finished; salt appears in various refined conditions, as the content of brine, and as rock salt; gypsum is sold at first hands, as crude, as ground, and as calcined. There is no uniformity and there is no way of arriving at the quantities and values of the quarry products except in the condition as first marketed. The desirability of continuing to base the figures of iron production on the output and value of pig iron may be open to some question, particularly as accurate records

of the production of ore and of the sources from which it is obtained are now available. In addition to putting a factitious value on the output, the distribution of the production of pig iron by States gives undue prominence to the States in which the blast furnaces are located and deprives the ore-producing States of proper credit.

The publication of the introductory chapter on mineral products by States, which accompanied the report for 1911, brought out the fact that in certain other mineral substances, particularly those of a metallic nature, some States did not receive the proper credit as originating the production. With metallic copper, lead, and zinc (as reported by the smelters, not by the producers of the ores from which the metals are obtained) considered as the primary products, the value of the production of some States was unduly augmented, while that of others was correspondingly understated. In the present chapter an attempt has been made to correct these discrepancies, so that in addition to crediting the iron-ore production to the originating States the recoverable value of the metallic contents of the gold, silver, copper, lead, and zinc is given for the ores produced according to the States in which they are mined. The 1911 figures, as published in the report for that year, have been revised for the present chapter. The States principally affected by these changes are Missouri and New Jersey.

With pig iron the basis of iron values, and the refined metals (smelter production) the basis of values for gold, silver, copper, lead, zinc, etc., the total value of the mineral production of the United States was $1,927,532,128 in 1911 and $2,243,630,326 in 1912, with Pennsylvania, Ohio, Illinois, and West Virginia as the four leading States. With iron ores as the basis of iron production, and with the recoverable metallic contents of ores as the basis of other metal output, the total value of the mineral production was $1,681,281,031 in 1911 and $1,917,818,084 in 1912. The same four States remain at the head, but in different order, and hold their prominence because of their leading positions in the production of coal. Pennsylvania, of course, outranks all others, and West Virginia, Illinois, and Ohio follow in the order given. These four States are credited with about 42 per cent of the total value of the mineral output of the United States. California, with no standing as a producer of pig iron, iron ore, or coal, is fifth in rank owing to its importance as a producer of petroleum and of gold. Michigan and Minnesota, as the most important producers of iron ore, rank sixth and ninth, respectively, in the value of their total production. Colorado, with gold, coal, and zinc as its principal products, is eleventh in rank. Montana, with copper the leading product, stands seventh, and Missouri, with zinc and lead as its chief products, ranks tenth. In the following table the States are arranged in the order of their rank as shown by the value of their mineral products in 1912, iron ore being taken as the basis of iron production and the recoverable contents of the precious and semiprecious metals as the basis of valuation in this regard.

Rank of States in value of mineral production in 1911 and 1912.

State.	Principal mineral products in 1912 (in order of value).	1911		1912			
		Rank.	Value.	Rank.	Value.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
Pennsylvania	Coal, natural gas, clay products, cement	1	$414,426,962	1	$445,790,022	+$31,363,060	+ 7.57
West Virginia	Coal, natural gas, petroleum, clay products	3	101,932,248	2	123,872,358	+ 21,940,110	+21.52
Illinois	Coal, petroleum, clay products, stone	2	106,275,115	3	123,068,867	+ 16,793,752	+15.80
Ohio	Coal, clay products, petroleum, natural gas	4	97,090,284	4	111,229,656	+ 14,139,372	+14.56
California	Petroleum, gold, cement, clay products	5	90,620,644	5	92,837,374	+ 2,216,730	+ 2.45
Michigan	Copper, iron ore, cement, salt	6	65,275,324	6	80,062,486	+ 14,787,162	+22.65
Montana	Copper, silver, coal, gold	7	53,498,194	7	71,620,873	+ 18,122,679	+33.88
Arizona	Copper, gold, silver, zinc	11	44,503,873	8	67,497,838	+ 22,993,965	+51.67
Minnesota	Iron ore, clay products, stone	8	53,395,881	9	66,672,729	+ 13,276,848	+24.86
Missouri	Zinc, lead, coal, clay products	10	51,932,906	10	58,332,550	+ 6,399,644	+12.32
Colorado	Gold, coal, zinc, silver	9	52,522,416	11	58,167,399	+ 5,644,983	+10.75
Oklahoma	Petroleum, coal, natural gas, cement	13	43,036,253	12	53,614,130	+ 10,577,877	+24.58
Utah	Copper, silver, lead, coal	12	43,774,331	13	51,004,942	+ 7,230,611	+16.52
Indiana	Coal, clay products, cement, stone	14	37,430,187	14	42,239,193	+ 4,809,006	+12.85
Nevada	Copper, gold, silver, zinc	16	34,501,832	15	39,111,828	+ 4,609,996	+13.36
New York	Clay products, stone, cement, iron ore	17	34,317,594	16	38,406,473	+ 4,088,879	+11.91
New Jersey	Clay products, zinc, cement, stone	15	34,663,435	17	36,881,930	+ 2,218,495	+ 6.40
Alabama	Coal, iron ore, clay products, stone	18	28,005,785	18	30,641,983	+ 2,636,198	+ 9.41
Kansas	Coal, natural gas, cement, clay products	19	25,237,043	19	26,554,967	+ 1,317,924	+ 5.22
Iowa	Coal, clay products, cement, stone	20	21,112,896	20	22,900,350	+ 1,787,454	+ 8.47
Texas	Petroleum, coal, clay products, cement	24	18,798,837	21	22,797,015	+ 3,998,178	+21.27
Alaska	Gold, copper, silver, tin	21	20,866,122	22	22,724,833	+ 1,858,711	+ 8 91
Kentucky	Coal, clay products, stone	23	19,296,614	23	22,452,984	+ 3,156,370	+16.36
Idaho	Lead, silver, gold, copper	22	19,441,545	24	21,816,390	+ 2,374,845	+12 22
Tennessee	Coal, copper, stone, phosphate rock	25	17,899,882	25	19,362,209	+ 1,462,327	+ 8 17
Louisiana	Petroleum, sulphur, natural gas	28	12,710,958	26	15,357,841	+ 2,646.883	+20.82
Washington	Coal, clay products, cement, stone	26	15,865,277	27	15,347,313	− 517,964	− 3.26
Virginia	Coal, clay products, iron ore, stone	27	13,713,566	28	14,995,842	+ 1,282,276	+ 9.35
New Mexico	Copper, coal, silver, zinc	34	8,176,229	29	14,391,355	+ 6,215,126	+76.01
Wisconsin	Zinc, iron ore, stone, clay products	29	12,032,158	30	14,192,287	+ 2,160,129	+17.95
Wyoming	Coal, petroleum, iron ore, gypsum	30	11,483,377	31	13,374,088	+ 1,890,711	+16.46
Maryland	Coal, clay products, stone, cement	32	9,386,515	32	10,916,671	+ 1,530,156	+16.30
Florida	Phosphate rock, clay products, fuller's earth, sand-lime brick.	31	10,250,228	33	10,272,594	+ 22,366	+ .22
Vermont	Stone, slate, talc and soapstone	33	8,434,516	34	9,113,912	+ 679,396	+ 8.05
South Dakota	Gold, stone, silver	35	8,047,259	35	8,436,240	+ 388,981	+ 4.83
Massachusetts	Stone, clay products, lime	36	6,623,077	36	6,654,514	+ 31,437	+ .47
Georgia	Clay products, stone, coal, cement	37	6,172,857	37	6,306,140	+ 133,283	+ 2.16
Arkansas	Coal, bauxite, stone, clay products	38	5,864,822	38	6,258,726	+ 393,904	+ 6.72

Rank of States in value of mineral production in 1911 and 1912—Continued.

State.	Principal mineral products in 1912 (in order of value).	1911		1912			
		Rank.	Value.	Rank.	Value.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
Maine	Stone, lime, clay products, mineral waters	39	$4,645,630	39	$3,925,526	− $720,104	−15.50
Connecticut	Clay products, stone, lime, mineral waters	41	3,151,588	40	3,715,480	+ 563,892	+17.89
North Carolina	Clay products, stone, mica	42	2,793,825	41	3,368,923	+ 575,098	+20.58
Oregon	Gold, clay products, sand and gravel	40	3,192,679	42	2,553,549	− 639,130	−20.02
New Hampshire	Stone, clay products	44	1,727,645	43	1,949,876	+ 222,231	+12.86
South Carolina	Clay products, phosphate rock, stone	43	1,803,579	44	1,606,989	− 196,590	−10.90
Nebraska	Clay products, stone, sand and gravel	45	1,316,168	45	1,490,582	+ 174,414	+13.25
Mississippi	Clay products, sand and gravel	47	1,052,842	46	1,242,528	+ 189,686	+18.02
North Dakota	Coal, clay products	48	957,425	47	1,025,741	+ 68,316	+ 7.14
Rhode Island	Stone, clay products	46	1,253,656	48	934,292	− 319,364	−25.47
Delaware	Stone, clay products, sand and gravel	49	491,657	49	425,360	− 66,297	−13.48
District of Columbia	Clay products, sand-lime brick	50	277,295	50	300,336	+ 23,041	+ 8.31
Total			[a] 1,681,281,031		[a] 1,917,818,084	+236,537,053	+14.07

[a] It must be remembered that in this table iron ore, not pig iron, is taken as the basis of iron valuation, and that in the case of other metals mine production (recoverable content of metals) is considered. With pig iron and the smelter figures for other metal production taken as the basis, in conformity with the usual custom, the total value of the mineral production of the United States in 1912 was $2,243,630,326, against $1,927,532,128 in 1911, the increase in the later year being $316,098,198, or 16.40 per cent.

It will be noted that in the 48 States, Alaska, and the District of Columbia, included in the foregoing table, there were 44 in which the value of the mineral production in 1912 exceeded that of 1911, and only 6 showed decreases. Five of the 6 States in which decreases were shown were relatively unimportant as mining States, being among the 12 States of lowest rank, and all 6 of them were in the second half according to rank. It will also be observed that the first 7 States maintain the same relative positions in both years, with the exception of West Virginia and Illinois, whose positions were reversed in 1912, but Arizona advanced from eleventh place in 1911 to eighth place in 1912, owing to the increased production of copper and a decided advance in the price of that metal. New Mexico carries off the honors in regard to the percentage of increase, with a gain of over 76 per cent, due also to the increased production of copper. Arizona, second in the percentage of increase, showed a gain of nearly 52 per cent, while Montana, third in this respect, had a gain of nearly 34 per cent. In each State copper was responsible for the increase in value. There were 7 additional States that showed an increase of 20 per cent or more, 8 whose increases were between 15 and 20 per cent, and 9 whose gains were between 10 and 15 per cent. The average increase was a little over 14 per cent. The first 4 States in the list—Pennsylvania, West Virginia, Illinois, and Ohio—owe their prominence as mining States to their production of coal. California, the fifth in rank, while the leading producer of gold, owes its position chiefly to the value of its petroleum production, which in 1912 was nearly double that of the value of its gold. Michigan holds sixth place because of its copper and iron ores; Montana and Arizona, seventh and eighth, respectively, have copper mining as their principal industry; Minnesota, ninth, presents iron ore as its principal product; Missouri, tenth, yields chiefly zinc and lead; Colorado, eleventh, contributes principally gold and coal; and Oklahoma, twelfth, lays claim to distinction because of its output of petroleum. More than 50 per cent of the total value of the mineral production is from the first 6 States, Pennsylvania, West Virginia, Illinois, Ohio, California, and Michigan, and nearly 25 per cent is from Pennsylvania alone. Of the 10 leading States, 5—Pennsylvania, West Virginia, Illinois, Ohio, and Michigan—are east of the Mississippi; 4—California, Montana, Arizona, and Missouri—are west of it; and 1—Minnesota—is divided by the river. The combined production of all the States east of Mississippi River, which aggregate less than 30 per cent of the total area of the country, exclusive of Alaska, is nearly two-thirds of the total, whereas the States west of the river, which aggregate about 70 per cent of the total area, contribute slightly more than one-third of the total value of output. The center of production, value of product considered, is in the western part of Illinois, a short distance above St. Louis, Mo. The States ranking first in the production of coal, iron ores (in eastern Minnesota), stone, clay products, natural gas, and most of the important nonmetallic substances, except petroleum and sulphur, are east of Mississippi River, while those holding first place in the production of gold, silver, copper, lead, zinc, and petroleum, and producing all the quicksilver, platinum, and sulphur lie west of the river.

The present chapter is designed primarily to review briefly the mineral resources of the several States and their production in 1911 and 1912. The statistics of production, according to substances, are discussed at length in the chapters devoted to the different subjects. It seems pertinent, however, in comparing the statistics of the production, by States, and in discussing the products which give them prominence, to call particular attention to a few interesting facts regarding some of the more important products. They group themselves naturally into three special classes—metals, fuels, and structural materials. The group of metals shows a notable increase in 1912 over 1911. One item only showed a decrease, the value of the gold produced in 1912 being less by nearly $3,500,000 than the output in 1911, the figures for the two years being $96,890,000 and $93,451,500. The largest proportionate increase in value was shown in the production of copper, which, although gaining only about 13 per cent in quantity, had a value in 1912 nearly 50 per cent larger than in 1911. Copper production increased from 1,097,232,749 pounds, valued at $137,154,092, in 1911 to 1,243,268,720 pounds, valued at $205,139,338, in 1912, an increase of 146,035,971 pounds in quantity and of $67,985,246 in value. Pig iron (from domestic ores) showed the largest gain in value with an increase of $89,043,895, or 28.42 per cent, from $313,334,558 in 1911 to $402,378,453 in 1912. The increase in quantity was 6,677,592 long tons, or about 30 per cent, from 22,303,603 tons to 28,981,195 tons. Zinc had the second largest percentage of increase in value (44.35 per cent), from $30,964,794 to $44,699,166. Silver increased 20.18 per cent, from $32,615,700 to $39,197,500, and lead showed the smallest gain (2.35 per cent), from $36,527,670 to $37,385,550. The average percentage of increase for the six metals was 27, and the combined increase in value was $174,764,693.

The three fuels—coal, petroleum, and natural gas—had a combined increase of $108,740,865, or 13.02 per cent, in 1912 over 1911. Coal contributed the largest part of the increase, but petroleum led in the percentage column. The coal production increased from 496,371,126 short tons, valued at $626,565,211, to 534,466,580 tons, valued at $695,606,071, a gain of 38,095,454 tons, or 7.67 per cent, in quantity, and of $69,040,860, or 11.02 per cent in value. Petroleum production increased from 220,449,391 barrels, valued at $134,044,752, to 222,113,218 barrels, valued at $163,802,334, the increase in quantity being 1,663,827 barrels, or 0.75 per cent, and in value $29,757,582, or 22.2 per cent. Natural-gas production increased in value from $74,621,534 to $84,563,957, a gain of $9,942,423, or 13.32 per cent.

Of the five substances grouped under structural materials, sand and gravel showed the largest percentage of increase (9.24), with cement second (8.31), and clay products third (6.73). Slate showed an increase of 5.5 per cent, and stone an increase of 1.52 per cent. The total value of these products in 1912 was $313,302,594, against $295,931,747 in 1911, the increase in 1912 amounting to $17,370,847, or 5.87 per cent.

The following table gives the production and value of the principal metals, fuels, and structural materials in 1911 and 1912:

Production and value of principal metals, fuels, and structural materials in the United States, 1911 and 1912.

Mineral.	Principal producing States in 1912 (in order of value).	1911			1912			Increase (+) or decrease (−) in value.			
								By minerals.		By groups.	
		Quantity.	Value.	Value by groups.	Quantity.	Value.	Value by groups.	Amount.	Per cent.	Amount.	Per cent.
Metals (from domestic ores):											
Pig iron [a].....long tons..	Pennsylvania, Ohio, Illinois, New York.	22,303,603	$313,334,558		28,981,195	$402,378,453		+$89,043,895	28.42		
Copper.....pounds..	Arizona, Montana, Michigan, Utah.	1,097,232,749	137,154,092		1,243,268,720	205,139,338		+67,985,246	49.57		
Gold.....fine ounces..	California, Colorado, Alaska, Nevada.	4,687,053	96,890,000		4,520,717	93,451,500		− 3,438,500	3.55		
Zinc.....short tons..	Missouri, New Jersey, Colorado, Wisconsin.	271,621	30,964,794	$647,486,814	323,907	44,699,166	$822,251,507	+13,734,372	44.35	+$174,764,693	26.99
Silver.....fine ounces..	Nevada, Utah, Montana, Idaho.	60,399,400	32,615,700		63,766,800	39,197,500		+ 6,581,800	20.18		
Lead.....short tons..	Missouri, Idaho, Utah, Colorado.	405,863	36,527,670		415,395	37,385,550		+ 857,880	2.35		
Fuels:											
Coal.....short tons..	Pennsylvania, Illinois, West Virginia, Ohio.	496,371,126	626,565,211		534,466,580	695,606,071		+69,040,860	11.02		
Petroleum.....barrels..	California, Oklahoma, Illinois, West Virginia.	220,449,391	134,044,752	835,231,497	222,113,218	163,802,334	943,972,362	+29,757,582	22.20	+108,740,865	13.02
Natural gas.....	West Virginia, Pennsylvania, Ohio, Oklahoma.	.....	74,621,534		.....	84,563,957		+ 9,942,423	13.32		
Structural materials:											
Clay products.....	Pennsylvania, Ohio, Illinois, New Jersey.	.....	127,717,621		.....	136,307,111		+ 8,589,490	6.73		
Stone.....	Pennsylvania, Vermont, New York, Ohio.	.....	77,108,567		.....	78,284,572		+ 1,176,005	1.52		
Cement [a].....barrels..	Pennsylvania, California, Indiana, Missouri.	76,567,150	64,218,957	295,931,747	85,925,651	69,554,385	313,302,594	+ 5,335,428	8.31	+ 17,370,847	5.87
Sand and gravel, short tons.	P ennsylvania, New York, Ohio, Illinois.	66,846,959	21,158,583		68,354,561	23,113,208		+ 1,954,625	9.24		
Slate.....	Pennsylvania, Vermont, Maine, Virginia.	.....	5,728,019		.....	6,043,318		+ 315,299	5.50		

[a] Marketed production.

INDIVIDUAL STATES.

ALABAMA.

Alabama ranks eighteenth among the States in the value of its mineral products, iron ore being taken as the basis of iron production. It ranks second among the States south of Mason and Dixon's line and Ohio River, West Virginia being the premier mineral producer among the Southern States. Alabama can not claim the distinction of being the leading State in the production of any important mineral substance, but it ranks third in the production of iron ore, fourth in quantity and fifth in value as a producer of pig iron, second in quantity and third in value of coke production, and seventh as a producer of coal. It is one of the few States which produce bauxite and graphite and ranks third in the production of each. Its production of the precious metals is insignificant, and while some progress has been made in the development of its quarrying and clay-working industries, these resources have not been exploited to the same extent as those of coal and iron.

Alabama's industrial progress so far as its mineral resources are concerned has depended on the development of the iron and steel industries with their collateral enterprises—the mining of coal and the manufacture of coke. These had their beginning in 1882. The boom which followed the discovery of the extensive dsposits of iron ore in the vicinity of Birmingham was without precedent in the industrial history of the United States, and the rush to Birmingham was paralleled only by the booms which followed such discoveries as the Comstock lode in Nevada and the Alaska gold fields. The essential difference between the rush to Birmingham and those to the other districts was that whereas in each place the boom had its inevitable collapse the reason back of the Birmingham rush had substantial foundation, and after the bursting of the original bubble there followed a quarter of a century of steady and healthy growth. The iron ores of Alabama, while inferior in quality to those of Lake Superior, have the advantage of contiguous deposits of good coking coal and of the limestone requisite for fluxing, as the result of which Birmingham, the Pittsburgh of the South, can manufacture pig iron cheaper than any other district of the world. The iron ores are principally non-Bessemer hematites and steel is produced chiefly by the open-hearth process. Prior to 1882, when the boom began, the coal production of Alabama had not amounted to as much as half a million tons in any one year. In 1885 it was nearly 2,500,000 tons; in 1886 it decreased to 1,800,000 tons, but after that it showed practically steady progress until in 1910 the maximum (16,111,462 short tons, valued at $20,236,853) was attained. A decline in the iron trade of 1911 caused a decrease in the production of coal in all States depending on the furnaces for their principal markets, and Alabama's production decreased to 15,021,421 short tons, valued at $19,079,949. In 1912, with some revival in the iron industry, the coal production was nearly equal to that of 1910, amounting to 16,100,600 short tons, with a value of $20,829,252, which exceeded that of 1910 by nearly $600,000.

In 1882 Alabama produced about 100,000 long tons of pig iron. The State's pig-iron output (marketed) in 1912 amounted to 1,987,753

long tons, an increase of more than 370,000 tons over 1911, and exceeding the previous high record of 1910 by 18,000 tons.

The coke production of Alabama in 1912 was 2,975,489 short tons, valued at $8,098,412, an increase from 2,761,521 tons, valued at $7,593,594 in 1911, but falling short both in quantity and value of the output in 1910.

The total value of the mineral production of Alabama, exclusive of the value of the pig iron but including the value of the iron ores, was $30,641,983 in 1912 and $28,005,785 in 1911, approximately two-thirds of which is represented by the output of the coal mines and one-fifth by the output of iron ore. The principal coal-producing counties are Jefferson, Walker, Bibb, and Tuscaloosa, in the order named. The principal iron-ore counties are Jefferson, Tuscaloosa, Etowah, and Franklin. The iron-making industry is centered in Birmingham and vicinity. The combined value of the pig iron and coke made in Alabama in 1912 approximated $30,000,000, but these values are not included in the total, as they are represented in the value of the iron ore and the coal produced. The clay-working industries yielded products in 1912 valued at $1,935,179, against $1,947,102 in 1911, the principal part of which is from the manufacture of common brick. The center of the clay-working industry is in Jefferson County, and Birmingham furnishes the principal market. Vitrified, fire, and front brick and sewer pipe are important products. The quarrying products of 1912 amounted to $842,300, against $923,998 in 1911. Limestone is the principal product, the greater part of which is used for flux in the iron furnaces. The cement production amounted to 593,911 barrels, valued at $529,359, in 1911, and 726,688 barrels, valued at $608,620, in 1912. Other products of commercial value are lime, mica, millstones, mineral waters, natural gas, sand, and gravel.

In the following table is presented a comparison of the mineral output of Alabama in 1911 and 1912. As stated above, the total does not include the value of pig iron nor of coke, but it does include the value of the coal made into coke and of the iron ore sold or used.

Mineral production of Alabama in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bauxite...long tons..	(a)	(a)			(a)	(a)		
Cement.....barrels..			593,911	$529,359			726,688	$608,620
Clay products, short tons	35,203	b $29,909		1,947,102	43,052	b $33,414		1,935,179
Coal.....do....	15,021,421	19,079,949			16,100,600	20,829,252		
Coke.....do....			2,761,521	b 7,593,594			2,975,489	b 8,098,412
Gold, fine ozs. (troy)..			915	18,916			809	16,724
Graphite, crystalline, pounds	(a)	(a)			(a)	(a)		
Iron ore...long tons..	3,955,582	4,876,106			4,776,545	5,734,371		
Iron, pig.....do....			1,617,150	b 17,379,171			1,987,753	b 21,371,053
Lime.....short tons..			76,406	300,787			79,957	297,178
Mica				(a)				
Millstones				(a)				(a)
Mineral waters, gallons sold	205,854	26,982			165,678	20,435		
Natural gas		(a)				(a)		
Sand and gravel, short tons	677,894	215,413			852,943	268,111		
Silver, fine ozs. (troy).			171	91			168	103
Stone		(c)		c 923,998		(c)		c 842,300
Miscellaneous		78,652		8,430		d 89,710		(d)
Total value, eliminating duplications..	$28,005,785				$30,641,983			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.
d Derived product included in raw product.

ALASKA.

Mining in Alaska is confined principally to the production of gold and copper, with a relatively small amount of silver. Considerable quantities of gypsum are mined, some stone is quarried, and small quantities of coal, lead, tin, and petroleum have been produced. According to Alfred H. Brooks, the geologist in charge of the division of Alaskan mineral resources, important progress was made in metalliferous mining during 1912, gold, copper, and silver all showing increased production. Mr. Brooks states that the production of placer gold was less in 1912 than in 1911, but that this deficiency was more than made up by the installation of large plants, notably dredges, which augurs well for the stability of the industry. There was also considerable progress in lode-gold mining. The production of gold increased from 815,276 fine ounces, valued at $16,853,256, in 1911 to 829,435 ounces, valued at $17,145,951, in 1912. Copper production also advanced, the recoverable metallic content of the copper ores produced amounting in 1912 to 29,230,491 pounds, valued at $4,823,031, against 27,267,878 pounds, valued at $3,408,485, in 1911. The output of silver was 515,186 ounces, valued at $316,839, in 1912, against 460,231 ounces, valued at $243,922, in 1911.

The development of the coal resources of the Territory has been held back by the lack of legislation permitting the exploitation of the known extensive and valuable fields. In 1912 the commercial product of coal amounted to 355 tons, in addition to which 900 tons were mined under the direction of the United States Bureau of Mines for

testing by the United States Navy. The imports of coal to Alaska amount to approximately 100,000 tons annually, but most of the transportation and manufacturing industries depend upon California oil for their fuel. As long as the supply of liquid fuel is available the incentive to invest in Alaskan coal resources will not be marked.

The following table gives the quantity and value of the mineral production of Alaska in 1911 and 1912:

Mineral production of Alaska in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Coal.....short tons..	900	$7,200	.....	.....	355	$2,840	.....	.....
Copper.....pounds..	.....	.....	27,267,878	$3,408,485	.....	.....	29,230,491	$4,823,031
Gold.....fine ounces (troy)..	.....	.....	815,276	16,853,256	.....	.....	829,435	17,145,951
Gypsum.....short tons..	(a)	.....	.....	(a)	(a)	.....	.....	(a)
Lead.....do....	.....	.....	(b)	(b)	.....	.....	(b)	(b)
Silver....fine ounces (troy)..	.....	.....	460,231	243,922	.....	.....	515,186	316,839
Stone.....	.....	(c)	.....	.....	.....	.....	.....	(c)
Tin.....short tons..	.....	.....	92	52,409	.....	.....	130	124,800
Miscellaneous.....	.....	(d)	.....	d 300,850	.....	.....	.....	311,372
Total value, eliminating duplications.....	$20,866,122				$22,724,833			

a Calcined in Washington State. Value included under "Miscellaneous."
b Smelter report shows small quantity of lead derived from concentrates of dry siliceous ores.
c Value included under "Miscellaneous."
d Raw product included in derived product.

ARIZONA.

Arizona ranks first among the States in the production of copper, and copper mining is by far the mainstay of the mining industry in the State. The recoverable copper content of the ores produced in Arizona in 1912 was 365,038,649 pounds. The value of this product was $60,231,377 in 1912. In 1911 the recoverable copper content of the ores produced in Arizona was 306,141,538 pounds, valued at $38,267,692. The increase in 1912 was 58,897,111 pounds, or 19.2 per cent, in quantity, and $21,963,685, or 57.4 per cent, in value. The total value of the mineral products of the State in 1911 was $44,503,873, and in 1912 it was $67,497,838, the copper product representing 86 per cent of the total in 1911 and 89 per cent of the total in 1912. The large increase in the production of copper was due principally to the development of steam-shovel operations on the low-grade schists and porphyry (concentrating) ores of the Ray district, in Pinal County, and the Miami district, in Gila County. The leading counties in the production of copper are Cochise, Greenlee, Gila, Pinal, Yavapai, and Pima. Second among the mineral products of Arizona is gold, in which the State ranks seventh. The only other important mineral product is silver, in which Arizona ranks sixth in production. The three metals—copper, gold, and silver—constitute nearly 98 per cent of the total production of the State. The gold production in 1912 was 181,997 fine ounces, valued at $3,762,210, against 165,951 ounces, valued at $3,430,503, in 1911. The silver production in 1912 amounted

to 3,490,387 ounces, valued at $2,146,588, against 3,276,571 ounces, valued at $1,736,583, in 1911. About two-thirds of the gold production is from siliceous ores mined in Mohave, Maricopa, Yavapai, Santa Cruz, and Yuma counties, and nearly one-third of the gold output is obtained in the reduction of copper ores. Cochise and Yavapai counties are the principal producers of silver, most of which comes from copper ores. Arizona produces also considerable quantities of lead and zinc, the former amounting in 1912 to 3,403 short tons, valued at $306,290, and the latter to 4,379 short tons, valued at $604,319. The total value of the metallic contents of the ores produced in Arizona in 1912 was $67,060,350, or more than 99 per cent of the total. The nonmetalliferous products are clay, gypsum, lime, quartz, sand and gravel, stone, sulphuric acid from copper smelting, and some gem material, principally chrysoprase.

The statistics of production in Arizona in 1911 and 1912 are shown in the following table:

Mineral production of Arizona in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				$106,882				$178,564
Copper.....pounds			306,141,538	38,267,692			365,038,649	60,231,377
Gems and precious stones				17,643				15,975
Gold ...fine ounces (troy)			165,951	3,430,503			181,997	3,762,210
Gypsum.....short tons	(a)			(a)	(a)			(a)
Lead.....do			5,137	462,355			3,403	306,290
Lime.....do			13,844	69,940			18,528	101,680
Quartz.....do	(a)	(a)			(a)	(a)		
Sand and gravel.....do	(a)	(a)			(a)	(a)		
Silver..fine ounces (troy)			3,276,571	1,736,583			3,490,387	2,146,588
Stone		(b)		b 55,714		(b)		b 67,124
Sulphuric acid (60° Baumé)c.....short tons			(a)	(a)			(a)	(a)
Tungsten ore (60 per cent concentrates).short tons			50	16,559			27	9,566
Zinc.....do			2,281	260,090			4,379	604,319
Miscellaneous		$13,765		66,147		$6,525		67,620
Total value, eliminating duplications	$44,503,873				$67,497,838			

a Value included under "Miscellaneous."
b Stone sold rough included in derived product.
c From copper smelting.

ARKANSAS.

Arkansas is first among the States in the production of two minerals, bauxite and novaculite, the former being the ore of aluminum and the latter the source of the larger part of the oilstones produced in the United States. The principal mineral product, however, is coal, the annual value of which constitutes over 50 per cent of the State's total. The total value of the mineral products in 1912 was $6,258,726, against $5,864,822 in 1911. The coal production was 2,100,819 short tons, valued at $3,582,789, in 1912, against 2,106,789 tons, valued at $3,396,849, in 1911. Coal was mined in 1912 in six counties, but nearly 70 per cent of the production came from Sebastian County. Franklin and Johnson counties together produced

about 27 per cent of the total. The coals of Arkansas are generally of high grade, particularly in the eastern part of the field, where they approach anthracite in character. The semianthracite of Arkansas is an excellent domestic fuel reaching markets as far north as Kansas City. Mining conditions are exacting, however, and the cost of labor is high. Moreover, competition with petroleum and natural gas (not so keen in 1912 as in the few years just preceding) and with the more cheaply mined coals from Illinois and Alabama to the east and with Colorado and New Mexico coals to the west, has kept the coal-mining industry of Arkansas practically at a standstill for the last 10 years. The production in 1912 was a little less than the average yearly output during the decade ended in that year.

Bauxite is second among the mineral products of the State. It is mined near Benton, in Saline County, and in Pulaski County, but as there are less than three producers the quantity and value of the output are not published. In 1912 the stone quarries of Arkansas furnished products valued at $513,844, exclusive of novaculite and of limestone burned for lime. In 1911 the quarry products were valued at $526,352. The clay-working industries, while not highly developed, take fourth place in the value of output. In 1912 the clay products of Arkansas, about 75 per cent of which is common brick, were valued at $462,605, a decrease of $18,000 from 1911. The sand and gravel pits yielded $393,639 in 1912 and $183,897 in 1911. The only metalliferous products of Arkansas are lead, zinc, and manganiferous ores, and of these zinc contributes more than $100,000 to the total value. Other commercial products are fuller's earth, lime, mineral waters, natural gas, phosphate rock, and slate. Some diamonds are found in Pike County.

The statistics of the mineral production of Arkansas in 1911 and 1912 are shown in the following table:

Mineral production of Arkansas in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bauxite.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Clay products.....	.....	.....	.....	$480,643	.....	.....	.....	$462,605
Coal.....short tons..	2,106,789	$3,396,849	.....	.....	2,100,819	$3,582,789	.....	.....
Fuller's earth.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	2,700	.....	.....	.....	1,175
Lead.....short tons..	.....	.....	64	5,760	.....	.....	31	2,790
Lime.....do....	.....	.....	22,847	109,067	.....	.....	22,404	102,833
Manganiferous ore..long tons..	2,177	4,354	.....	.....	1,332	2,997	.....	.....
Mineral waters..gallons sold..	1,560,157	118,994	.....	.....	1,396,032	132,257	.....	.....
Natural gas.....	.....	(a)	.....	.....	.....	(a)	.....	.....
Oilstones.....	.....	.....	.....	(a)	.....	.....	.....	112,047
Phosphate rock....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Sand and gravel...short tons..	1,007,589	183,897	.....	.....	1,217,740	393,639	.....	.....
Slate.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone.....	.....	(b)	.....	b526,352	.....	(b)	.....	b 513,844
Zinc.....short tons..	.....	.....	664	75,696	.....	.....	748	103,224
Miscellaneous.....	.....	864,043	.....	96,467	.....	c 848,526	.....	(c)
Total value, eliminating duplications.....	$5,864,822				$6,258,726			

a Value included under "Miscellaneous."
b Stone sold rough included in derived product.
c Derived product included in raw product.

CALIFORNIA.

California, first among the States west of Mississippi River and fifth among all the States in the total value of its mineral production, rests its principal claim to distinction as a mineral producer on its output of petroleum, in which at the present time it leads all the other States, as Pennsylvania does in the production of coal. In the quantity of petroleum produced California is credited with nearly 40 per cent of the total output of the United States. The value of the petroleum product of the State is about 42 per cent of its total mineral output. In former years the mineral industry in California was confined largely to the production of gold, which still holds second place in the mineral production of the State. California continues to rank first among the States in the output of gold. At the present time petroleum and gold combined represent about 65 per cent of California's mineral output.

Kern County, which contains the Midway, Kern River, McKittrick, Sunset, and Lost Hills fields or districts, is by far the most important in the production of petroleum, yielding 57 per cent of the total production of the State in 1911 and 58 per cent in 1912. Fresno County, which contains the Coalinga field, was second in importance, yielding nearly 25 per cent of the total production. The remainder of the output came from Los Angeles, Orange, Ventura, Santa Barbara, San Luis Obispo, and Santa Clara counties. The principal increase in production in 1912 was in Kern County, which showed a gain of over 4,300,000 barrels. Fresno County increased its production nearly 1,500,000 barrels, but in most of the counties of smaller production a decrease was shown.

The more important gold-producing counties are Amador, Yuba, Butte, Nevada, Sacramento, and Tuolumne, all of which produced over $1,000,000 worth of gold in 1912 and four of which exceeded $2,000,000. In 1911 there were two more counties, Calaveras and Shasta, which were credited with gold production in excess of $1,000,000. Of the total gold production of California, about 55 per cent is derived from deep mines and about 45 per cent from placers. Of the deep-mine gold about 94 per cent is obtained from siliceous ores, the other 6 per cent being from copper and lead ores. The principal dredging fields are at Oroville, Butte County, at Folsom, Sacramento County, and near Marysville, Yuba County. The principal deep-mine production is from the Mother Lode region in Amador, Nevada, and Tuolumne counties.

Next to gold the principal metal product of California is copper, chiefly from Shasta and Calaveras counties, the former contributing nearly 80 per cent of the total and the latter between 15 and 20 per cent. The production of copper decreased from 36,316,136 pounds in 1911 to 33,451,672 pounds in 1912, but the value increased from $4,539,517 to $5,519,526.

The silver produced, which was relatively small in quantity compared with gold and copper, is also principally from Shasta and Calaveras counties and is largely recovered as a by-product in the copper mines.

The production of lead and zinc is small, most of the lead being from Inyo County and most of the zinc from one mine, the ores of

which are shipped to eastern works for treatment. The recoverable metallic content of the lead ores produced in California in 1912 was 572 short tons, against 699 short tons in 1911. The zinc production has increased about 50 per cent, from 1,404 short tons in 1911 to 2,173 tons in 1912.

One of the important mining industries in California is the manufacture of Portland cement, the value of this product exceeding $8,000,000 in both 1911 and 1912, although in the later year the production was less than in 1911 by nearly 225,000 barrels in quantity and over $500,000 in value.

The value of the clay products of the State increased nearly $1,000,000 in 1912 over 1911, being, respectively, $5,912,450 and $4,915,866.

The total value of the quarry products, which consist chiefly of granite, trap rock, and limestone, decreased from $4,676,902 in 1911 to $3,902,313 in 1912.

The only other mineral products of the State which exceeded a million dollars in value were asphalt ($2,186,403 in 1912 and $2,291,754 in 1911), borax ($1,127,813 in 1912 and $1,569,151 in 1911), and natural gas ($1,134,456 in 1912 and $800,714 in 1911).

In addition to being first in the production of petroleum and of gold, California is also the premier producing State in asphalt, platinum, and quicksilver, and enjoys a monopoly in the production of borax and magnesite, and in recent years of chromite, although the combined value of these six substances is less than $3,500,000. The other mineral products of commercial importance in California are coal, feldspar, fuller's earth, gem materials, gypsum, infusorial earth, iron ore, lime, manganese ore, mineral paints, mineral waters, pumice, pyrite, quartz (abrasive), salt, sand and gravel, sand-lime brick, sulphuric acid from copper smelting, talc, and tungsten (concentrates).

The total value of the mineral production in 1912 was $92,837,374, against $90,620,644 in 1911.

The totals by substances are shown in the following table:

Mineral production of California in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt..short tons..	36,081	$215,230	169,116	$2,076,524	36,111	$92,139	213,220	$2,094,264
Borax.....do....	53,330	1,569,151	.....	.....	42,315	1,127,813	.....	.....
Briquets, fuel..do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Cement.....barrels..	.....	.....	6,317,701	8,737,150	.....	.....	6,093,790	8,215,894
Chromite..long tons..	120	1,629	.....	.....	201	2,753	.....	.....
Clay products, short tons.....	87,256	b 112,316	.....	4,915,866	102,520	b 139,919	.....	5,912,450
Coal.....do....	10,747	16,097	.....	.....	10,978	23,601	.....	.....
Copper.....pounds..	.....	.....	36,316,136	4,539,517	.....	.....	33,451,672	5,519,526
Feldspar..short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Fuller's earth..do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	28,370	.....	.....	.....	45,330
Gold..fine ozs. (troy).	.....	.....	954,870	19,738,908	.....	.....	953,639	19,713,478
Gypsum..short tons..	43,855	.....	.....	204,264	47,741	.....	.....	219,317
Infusorial earth.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Iron ore...long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lead.....short tons..	.....	.....	699	62,915	.....	.....	572	51,512
Lime.....do....	.....	.....	72,858	564,175	.....	.....	72,978	555,822
Magnesite.....do....	9,375	75,000	.....	.....	10,512	105,120	.....	.....
Manganese ore, long tons.....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Mineral paints, natural pigments, short tons.....	.....	.....	(a)	(a)	.....	.....	290	3,610
Mineral waters, gallons sold.....	2,310,237	578,439	.....	.....	2,089,951	532,971	.....	.....
Natural gas.....	.....	800,714	.....	.....	.....	1,134,456	.....	.....
Petroleum...barrels..	81,134,391	38,719,080	.....	.....	86,450,767	39,213,588	.....	.....
Platinum, fine ounces (troy).....	.....	.....	511	14,873	.....	.....	603	19,899
Pumice..short tons..	.....	.....	.....	.....	(a)	(a)	.....	.....
Pyrite....long tons..	48,415	182,787	.....	.....	61,812	201,453	.....	.....
Quartz...short tons..	.....	.....	.....	.....	(a)	(a)	.....	.....
Quicksilver...flasks..	.....	.....	18,860	867,749	.....	.....	20,524	863,034
Salt.....barrels..	23,350	11,442	1,062,813	543,917	(a)	(a)	1,064,286	609,396
Sand and gravel, short tons.....	1,911,652	416,980	.....	.....	2,189,432	518,516	.....	.....
Sand-lime brick.....	.....	.....	.....	19,535	.....	.....	.....	33,860
Silver..fine ozs. (troy).	.....	.....	1,270,445	673,336	.....	.....	1,300,136	799,584
Stone.....	.....	(c)	.....	c4,676,902	.....	(c)	.....	c3,902,313
Sulphuric acid (60° Baumé) d, short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a) (e)
Talc.....do....	.....	.....	(a)	(a)	.....	.....	1,169	15,653
Tungsten ore(60° concentrates), short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Zinc.....do....	.....	.....	1,404	160,001	.....	.....	2,173	299,846
Miscellaneous.....	.....	4,915	.....	312,525	.....	40,835	.....	1,112,817
Total value, eliminating duplications....	$90,620,644				$92,837,374			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.
d From copper smelting.
e Includes small value for electrolyte.

COLORADO.

Colorado ranks eleventh among the mineral-producing States, with iron ore as the basis of iron production. Colorado is not the leading State in any important mineral product, although it closely approximates California in the production of gold and has in former years been the leading State in that regard. It now leads in the produc-

tion of tungsten ores and vanadium minerals and ranks second in the production of gold, third in the production of zinc and fluorspar, and fourth in lead. The product of chief value in Colorado is gold, with coal as second. The total value of the mineral products of Colorado in 1912 was $58,167,399, of which the gold mines produced $18,588,562. In 1911 the gold output was valued at $19,001,975 and the total was $52,522,416. The coal production of Colorado in 1912 amounted to 10,977,824 short tons, valued at $16,345,336, against 10,157,383 short tons, valued at $14,747,764, in 1911. From these statistics it appears that the value of the gold produced is about 30 or 35 per cent of the total and that of the coal between 25 and 30 per cent. Teller County produces more than one-half of the total gold output of the State, all from deep mines and all from siliceous ores unmixed with other metals. The other important gold-producing counties are San Miguel, Ouray, Lake, San Juan, Gilpin, and Clear Creek. Ninety-five per cent of the total output of gold in the State is from siliceous ores. The leading county in the production of coal is Las Animas, 45 per cent of the total output of coal in Colorado coming from that county. Huerfano County, second in production, yielded about 17 per cent of the total coal output in the State in 1912, the other more important counties being Boulder, Fremont, Gunnison, Weld, and Routt. The most striking increase in Colorado's mineral production in 1912 was in the output of the zinc mines. The recoverable zinc content of the ores mined in Colorado increased from 47,304 short tons, valued at $5,392,625, in 1911, to 66,111 tons, valued at $9,123,374, in 1912, making zinc mining third in importance among Colorado's mining industries. Colorado leads all the Western States in the manufacture of pig iron. The ore from which the iron is made, however, is mined principally in New Mexico and Wyoming, and the value of the pig iron produced is not included in the total mineral production of Colorado. Silver ranks fourth in the value of output, amounting in 1912 to $5,050,423, against $3,884,989 in 1911. The silver production is largely from dry and siliceous gold and silver ores and from silver-lead ores, the principal producing counties being, in order, Lake, San Miguel, Mineral, Ouray, Pitkin, Clear Creek, San Juan, and Gilpin. The same counties furnished the larger part of the lead production, which in 1912 amounted to 37,621 short tons, valued at $3,385,902, compared with 34,840 short tons, valued at $3,135,568, in 1911. The quantity here stated is that of the recoverable lead content of the ore mined, not the quantity and value of the lead smelted in the State. The other industries which yield products exceeding $1,000,000 in value are stone quarrying and clay and copper mining. The value of the stone produced in 1912, most of which was marble, with limestone second, was $1,420,607. The clay products, exclusive of the raw clay sold, were worth $1,437,394, and the recoverable copper content of ore mined was worth $1,172,705. Other mineral products of the State in 1912 were cement, fluorspar, fuller's earth, gem materials, gypsum, iron ore, lime, manganiferous ores, mica, mineral waters natural gas, petroleum, sand and gravel, sand-lime brick, sulphuric acid from zinc smelting, tungsten (concentrates), and uranium and vanadium ores.

The details of production during the last two years are shown in the following table:

Mineral production of Colorado in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	95,127	b $83,636	.....	$1,606,709	72,435	b $72,105	.....	$1,437,394
Coal.....short tons..	10,157,383	14,747,764	.....	.....	10,977,824	16,345,336	.....	.....
Coke.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	972,941	b3,043,994
Copper.....pounds..	.....	.....	8,024,488	1,003,061	.....	.....	7,007,303	1,172,705
Fluorspar..short tons..	(a)	(a)	.....	.....	1,639	9,834	.....	.....
Fuller's earth....do....	.....	.....	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	2,520	.....	.....	.....	4,506
Gold, fine ounces (troy).....	.....	.....	919,221	19,001,975	.....	.....	899,222	18,588,562
Graphite, amorphous, short tons.....	(a)	(a)	.....	.....	.....	.....	.....	.....
Grindstones.....	.....	.....	.....	(a)	.....	.....	.....	.....
Gypsum...short tons..	26,226	.....	.....	67,199	(a)	.....	.....	(a)
Iron ore.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lead.....short tons..	.....	.....	34,840	3,135,568	.....	.....	37,621	3,385,902
Lime.....do....	.....	.....	6,403	34,614	.....	.....	7,281	36,478
Manganiferous ore, long tons.....	41,753	109,340	.....	.....	48,618	12,646	.....	.....
Mica.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Mineral waters, gallons sold.....	1,436,066	104,763	.....	.....	1,178,308	75,314	.....	.....
Natural gas.....	.....	(a)	.....	.....	.....	(a)	.....	.....
Petroleum.....barrels..	226,926	228,104	.....	.....	206,052	199,661	.....	.....
Sand and gravel, short tons.....	247,666	65,366	.....	.....	112,514	45,983	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver, fine ounces (troy).....	.....	.....	7,330,168	3,884,989	.....	.....	8,212,070	5,050,423
Stone.....	.....	(c)	.....	c1,514,827	.....	(c)	.....	c1,420,607
Sulphuric acid (60° Baumé)d, short tons.	.....	.....	(a)	(a)	.....	.....	(a)	(a) (e)
Tungsten ore (60 per cent concentrates) short tons.....	.....	.....	730	234,513	.....	.....	812	297,533
Uranium and vanadium ores, short tons.	.....	.....	8,400	302,000	.....	.....	(a)	(a)
Zinc.....short tons..	.....	.....	47,304	5,392,625	.....	.....	66,111	9,123,374
Miscellaneous.....	.....	115,127	.....	9,112,517	.....	102,736	.....	6,285,149
Total value, eliminating duplications....	$52,522,416				$58,167,399			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.
d From zinc smelting.
e Includes small value for electrolyte.

CONNECTICUT.

Connecticut lays small claim to importance as a mineral producer, the total value of the mineral products of the State being less than $4,000,000 annually, of which approximately 80 per cent is derived from its quarries and clay pits. An inconsiderable quantity of iron ore is mined, and a small quantity of pig iron is made in Connecticut, but aside from that there is in the State no metal mining of any sort, nor any production of mineral fuel. The quarrying industry yielded products valued at $1,467,458 in 1912 compared with $1,215,462 in 1911. The principal stone quarried is designated in the trade as granite, although much of the material quarried under the name of granite is gneiss. The quarrying of trap rock is also an impor-

tant industry, the value of the output in 1912 being about 75 per cent of that of granite or gneiss, the latter being used chiefly for riprap building, monumental work, and paving blocks, in the order named, whereas more than 90 per cent of the trap rock is crushed for road making, railroad ballast, and concrete.

According to Prof. William North Rice, superintendent of the Connecticut Geological and Natural History Survey, granite, or gneiss, is quarried in every county in the State. The principal operations are in New Haven and New London counties, and there are others of considerable importance in Windham and Fairfield counties. Trap rock is produced chiefly in Hartford and New Haven counties. In addition to granite and trap rock, commercial quarries of red sandstone are operated in Hartford, Middlesex, and New Haven counties, and some marble has been produced in Litchfield County. The clay-working establishments of the State are located principally in the Connecticut River valley, the product consisting chiefly of common brick, which represents nearly 90 per cent of the total output of clay. Lime to the value of $371,356 was produced in 1912 compared with $328,904 in 1911. The lime-producing counties are Fairfield and Litchfield, in the extreme western part of the State.

Connecticut is the third State in the Union in the production of feldspar, the output in 1912 amounting to 19,075 short tons, valued at $94,097, against 16,497 tons, valued at $73,557, in 1911. Connecticut's other commercial mineral products are infusorial earth, mineral waters, quartz, sand-lime brick, sand, and gravel. The total value of the mineral products of the State, as shown in the following table, was $3,151,588 in 1911 and $3,715,480 in 1912.

Mineral production of Connecticut in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				$1,284,166				$1,507,787
Feldspar, short tons	16,497	$73,557			19,075	$94,097		
Infusorial earth				(a)				(a)
Iron ore, long tons	(a)	(a)			(a)	(a)		
Iron, pig, do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lime, short tons			69,719	328,904			75,981	371,356
Mineral waters, gallons sold	2,164,701	182,744			2,110,231	153,383		
Quartz, short tons	(a)	(a)			(a)	(a)		
Sand and gravel, do	20,270	10,559			20,823	7,805		
Sand-lime brick				(a)				(a)
Stone		(c)		c1,215,462		(c)		c1,467,458
Miscellaneous		55,436		243,880		100,394		419,279
Total value, eliminating duplications	$3,151,588				$3,715,480			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

DELAWARE.

Delaware's mineral production is limited to its quarries, to its clay, sand, and gravel pits, and to mineral waters. All of these are of

little importance compared with those of other States. The total mineral production of Delaware in 1912 was valued at $425,360, of which $193,074 was represented by the output of the stone quarries and $162,216 by the clay products. In 1911 the total mineral production was valued at $491,657, of which $218,234 was furnished by the quarries and $200,610 by the clay works.

The statistics of mineral production in Delaware in 1911 and 1912 are given in the following table:

Mineral production of Delaware in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products....short tons..	7,950	a$46,024	.....	$200,610	13,688	a$61,754	.....	$162,216
Mineral waters .gallons sold..	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Sand and gravel .short tons..	137,205	65,813	.....	.....	129,157	62,047	.....	.....
Stone.....	.....	(c)	.....	c218,234	.....	(c)	.....	c193,074
Miscellaneous.....	.....	7,000	.....	.....	.....	8,023	.....	.....
Total value, eliminating duplications.....	$491,657				$425,360			

a Value not included in total value.
b Value included under "Miscellaneous."
c Stone sold rough included in derived product.

DISTRICT OF COLUMBIA.

The mineral production in the District of Columbia is principally the output of the clay beds in the vicinity of Washington. The products from these are common building brick, drain tile, sewer pipe, and fireproofing. A small quantity of stone is quarried for use in concrete for foundations and for road making, but no output was reported for 1912. One plant for making sand-lime brick is established in the District, and the waters from two springs are sold commercially.

The statistics of mineral production in the District of Columbia in 1911 and 1912 are shown in the following table:

Mineral production of the District of Columbia in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.....	.....	.....	.....	a$227,520	.....	.....	.....	a$217,486
Mineral waters..gallons sold..	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Sand-lime brick.....	.....	.....	.....	(b)	.....	.....	.....	(b)
Stone.....	.....	(b)	.....	.....	.....	.....	.....	.....
Miscellaneous.....	.....	$32,315	.....	17,460	.....	(c)	.....	c 82,850
Total value, eliminating duplications.....	$277,295				$300,336			

a Exclusive of pottery, value for which is included under "Miscellaneous."
b Value included under "Miscellaneous."
c Raw product included in derived product.

FLORIDA.

Florida secures recognition as a mining State of some importance by reason of its production of phosphate rock, which constitutes over 90 per cent of the value of the State's total mineral output. Public attention was first called to the possibilities of this now important industry in Mineral Resources of the United States for 1884, but workable deposits were not discovered until 1888 and production on a commercial scale began in 1889. The value of the phosphate production of Florida now approximates $10,000,000 annually. Formerly four kinds of phosphate rock were produced—hard rock, soft rock, land pebble, and river pebble. Soft rock has not been produced for several years, and only an insignificant amount of river pebble is now mined. Hard rock is generally of higher grade than pebble and at one time was the only phosphate for which there was any demand for export. During recent years, however, the grade of land-pebble phosphate has been greatly improved by the methods of mining and treatment employed, and the export shipments from Florida now include not only practically all the hard rock produced but also about one-third of the land pebble. In his report on the production of phosphate rock in Florida in 1912, Dr. E. H. Sellards, the State geologist, states that the foreign shipments of phosphate rock from Florida in that year amounted to 1,203,005 long tons. This was about 700,000 tons more than the total production of hard rock. The difference represented the quantity of pebble exported and was a little more than one-third of the pebble production. Hard rock usually commands about twice the price per ton of pebble; the production of pebble is about four times that of hard rock, but the value is only twice as large. In 1912 the total production of phosphate rock in Florida was 2,406,899 long tons, valued at $9,461,297, of which the combined production of land and river pebble constituted 1,913,418 long tons, valued at $6,168,129, or $3.22 per ton, while the output of hard rock was 493,481 long tons, valued at $3,293,168, an average value per ton of $6.67. Florida is by far the leading State in the production of phosphate rock, its output representing over 80 per cent, both in quantity and value, of the total output in the United States. The leading counties, according to value of marketed product, are Polk, Alachua, Citrus, Hillsborough, and Marion. Florida is also the premier State in the production of fuller's earth, the variety of clay used chiefly for filtering and clarifying animal, mineral, and vegetable oils. The production of fuller's earth, while relatively large for that industry, is of minor importance when considered with the total mineral production of the State. The production of fuller's earth decreased in 1912, compared with 1911, but no statement of the output in the later year can be given, owing to the necessity of withholding certain confidential information furnished to the Geological Survey by producers. Florida leads also in the production of ball clay, a very plastic clay used in giving plasticity to the body of high-grade pottery. The manufactured clay products of the State, valued at $272,766 in 1912, against $217,535 in 1911, are nearly all common brick. The manufacture of sand-lime brick is an industry of considerable importance in Florida, and because of the marked increase in production (from the value of $56,274 in 1911 to $121,378

in 1912) the State advanced from sixth to third place in this line of industry. The other mineral products of Florida are lime, mineral waters, sand and gravel, and stone.

The total value of the mineral products of the State, as shown in the following table, was $10,272,594 in 1912, compared with $10,250,228 in 1911.

Mineral production of Florida in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.....short tons..	24,167	a$114,751	.....	$217,535	(a) (b)	(a) (b)	.....	$272,766
Fuller's earth.....do....	27,658	265,571	.....	.....	(b)	(b)	.....	.....
Lime.....do....	.....	.....	10,867	49,221	.....	.....	12,327	69,938
Mineral waters.....gallons sold..	114,416	19,330	.....	.....	123,485	$17,521	.....	.....
Phosphate rock.....long tons..	2,436,248	9,473,638	.....	.....	2,406,899	9,461,297	.....	.....
Sand and gravel.....short tons..	112,776	33,339	.....	.....	115,450	21,050	.....	.....
Sand-lime brick.....	.....	.....	.....	56,274	.....	.....	.....	121,378
Stone.....	.....	.....	.....	(b)	.....	(c)	.....	(b)
Miscellaneous.....	.....	.....	.....	135,320	.....	(c)	.....	c428,384
Total value, eliminating duplications.....	$10,250,228				$10,272,594			

a Value not included in total value.
b Value included under "Miscellaneous."
c Raw product included in derived product.

GEORGIA.

Although ranking second among all the States in the production of five mineral substances (asbestos, barytes, bauxite, mineral paints (natural pigments), and fuller's earth), Georgia is of relatively minor importance in the value of its total mineral output. In the list of States it stands thirty-seventh, with an aggregate annual output valued at a little over $6,000,000. It is not a metal producer of any importance, and the only mineral fuel it produces is coal, a small amount of which is mined annually in the northwest corner of the State. The branches of the mining industry that furnish the principal portion of the product are, however, those which indicate a healthful development of the Commonwealth, namely, the quarries and the clay-working establishments. In the production of stone Georgia ranks first among the Southern States and eleventh among all the States of the Union. It is third among the Southern States and twelfth among the States in the value of its clay products. Georgia's granites have a high reputation for building, and Georgia marbles are highly prized for their structural and decorative possibilities. In 1912 the total value of the stone produced in the State of Georgia was $1,983,016, against $1,967,077 in 1911. The principal stone-quarrying counties are Dekalb and Hancock for granite, and Pickens for marble. The manufactured clay products in 1912 were valued at $2,806,541, an increase from $2,636,380 in 1911. In addition to the manufactured clay products, 75,815 short tons of raw clay, valued at $244,953, were sold in 1912. In 1911 the raw clay sold amounted to 68,161 short tons, valued at $223,462. Common

brick represents about 60 per cent of the total manufactured clay products, and sewer pipe less than 25 per cent of the total. Bibb County is the principal clay-working county of the State and the chief producer of common and front brick and sewer pipe. Common brick is also extensively manufactured in Richmond and Fulton counties. The principal raw clay product of the State is a white clay (used in the manufacture of paper), of which in 1912 Georgia produced 48,482 short tons, valued at $210,908. Georgia is the principal producer of this grade of clay.

The production of coal, which, as stated, is limited to the northwest corner of the State (in Dade and Walker counties), increased from 165,210 short tons, valued at $246,208, in 1911, to 227,503 tons, valued at $338,426, in 1912. The production of cement decreased from 368,462 barrels, valued at $330,186, in 1911, to 359,769 barrels, valued at $311,616, in 1912. Georgia is one of the chief sources of supply for ocher, which is included in its production of mineral paints—10,112 tons, valued at $101,819, in 1912. Other products of considerable importance in 1912 were bauxite, fuller's earth, iron ore, mineral waters, sand, and gravel, while those of minor importance are asbestos, barytes, gold, infusorial earth, lime, pyrite, sand-lime brick, and silver. The total value of the mineral products of Georgia in 1912 amounted to $6,306,140, against $6,172,857 in 1911, as shown in the following table:

Mineral production of Georgia in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Barytes.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Bauxite.....long tons..	(a)	(a)	.....	.....	19,587	$80,701	.....	.....
Cement.....barrels..	.....	.....	368,462	$330,186	.....	.....	359,769	$311,616
Clay products, short tons.....	68,161	b$223,462	.....	2,636,380	75,815	b 244,953	.....	2,806,541
Coal.....short tons..	165,210	246,208	.....	.....	227,503	338,426	.....	.....
Coke.....do....	.....	.....	37,553	b 135,190	.....	.....	43,158	b 161,842
Fuller's earth.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gold..fine ounces (troy)..	.....	.....	1,697	35,070	.....	.....	695	14,360
Infusorial earth.....	.....	.....	.....	c	.....	.....	.....	(a)
Iron ore.....long tons..	207,279	315,704	.....	.....	135,337	227,282	.....	.....
Iron, pig.....do....	.....	.....	3,519	b 52,060	.....	.....	.....	.....
Lime.....short tons..	.....	.....	6,282	24,067	.....	.....	(a)	(a)
Mineral paints, natural pigments...short tons..	.....	.....	8,515	71,197	.....	.....	10,112	101,819
Mineral waters, gallons sold.....	981,080	97,752	.....	.....	861,365	55,031	.....	.....
Pyrite.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Sand and gravel, short tons.....	518,885	175,734	.....	.....	445,122	171,129	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver, fine ounces (troy).....	.....	.....	212	112	.....	.....	77	47
Slate.....	.....	.....	.....	(a)	.....	.....	.....	.....
Stone.....	.....	(c)	.....	c1,967,077	.....	(c)	.....	c1,983,016
Talc.....short tons..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Miscellaneous.....	.....	226,878	.....	46,492	.....	137,695	.....	78,477
Total value, eliminating duplications.....	$6,172,857				$6,306,140			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

IDAHO.

The Cœur d'Alene lead-silver mining district, in Shoshone County, Idaho, is the center of the mining industry of that State. Lead is the product of chief value, constituting approximately 60 per cent of the State's total mineral production. All but about 6 per cent of the refined lead is from the Cœur d'Alene district. In 1912, out of a total mineral production valued at $21,816,390, the recoverable lead content of ores mined in Idaho was 142,093 short tons, valued at $12,788,355, against 136,278 short tons, valued at $12,265,044, in 1911, when the total mineral production was valued at $19,441,545. Idaho ranks second among the States in the production of lead ores, its output being exceeded by the soft-lead production of Missouri. Second in importance in the mineral products of the State is silver, in which Idaho ranks fourth as a producer. The recoverable silver content of the Idaho ores mined in 1912 was valued at $5,101,268, against $4,343,952 in 1911. Shoshone County yields 91 per cent of the silver produced in the State. Copper, gold, and zinc are also produced in significant quantities in the State. The gold production in 1912 was valued at $1,381,214, against $1,372,387 in 1911. In this one metal only Shoshone County is not the most important producer, Boise County claiming the credit for 36 per cent of the total production, followed somewhat closely by Owyhee County, with Lemhi County third. The recoverable copper content of the ores produced in Idaho was 7,492,152 pounds, valued at $1,236,205, in 1912, an increase from 5,152,937 pounds, valued at $644,117, in 1911. Shoshone County yields 59 per cent of the copper output of the State. The zinc production (recoverable metallic content of ores) was 6,953 short tons, valued at $959,479, in 1912, against 4,170 tons, valued at $475,394, in 1911. The total value of the metals contained in the ores produced in Idaho in 1912 was $21,466,521, or 98.4 per cent of the total mineral production. The total value of the nonmetallic products was $339,716, or 1.6 per cent of the total. The nonmetallic products consist of clay products, coal (lignite), gem materials, lime, mica, phosphate rock, salt, sand, gravel, sand-lime brick, and stone (principally granite and limestone), only one of which, the clay products, contains a total value as great as $150,000. The nonmetallic resource of greatest promise is phosphate, of which there are deposits in the southeastern part of the State extending over into northeastern Utah and southwestern Wyoming. As the agricultural industries of the Western States are developed this necessary soil food, which is abundant in the region mentioned, should become one of the important items in the mineral production of Idaho.

The output and value of the mineral production of Idaho, by substances, in 1911 and 1912 are shown in the following table:

Mineral production of Idaho in 1911 and 1912.

Product.	1911.				1912.			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products, short tons	(a) (b)	(a) (b)		(a)	(a) (b)	(a) (b)		(a)
Coal, short tons	1,805	$4,808			2,319	$6,603		
Copper, pounds			5,152,937	$644,117			7,492,152	$1,236,205
Gems and precious stones								100
Gold, fine ounces (troy)			66,389	1,372,387			66,816	1,381,214
Iron ore, long tons	(a)	(a)			(a)	(a)		
Lead, short tons			136,278	12,265,044			142,093	12,788,355
Lime, do			6,809	38,088			7,402	42,380
Mica								(a)
Mineral waters, gallons sold	(a)	(a)						
Phosphate rock, long tons	(a)	(a)			(a)	(a)		
Salt, barrels	71	120	243	412			(a)	(a)
Sand and gravel, short tons	(a)	(a)			(a)	(a)		
Sand-lime brick				(a)				25,121
Silver, fine ounces (troy)			8,196,136	4,343,952			8,294,745	5,101,268
Stone		(c)		c 64,250		(c)		c 63,974
Tungsten ore (60 per cent concentrates), short tons			(a)	(a)			(a)	(a)
Zinc, short tons			4,170	475,394			6,953	959,479
Miscellaneous		61,772		171,576		22,898		188,923
Total value, eliminating duplications	$19,441,545				$21,816,390			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

ILLINOIS.

With iron ore rather than pig iron considered as the basis of iron production, Illinois ranks third among all the States in the value of its mineral production. Illinois is an important manufacturer of pig iron, being exceeded in this respect only by Pennsylvania and Ohio, but it produces no iron ore. The iron furnaces, located principally in the northern part of the State, convenient to lake transportation, receive their supplies of iron ore from Lake Superior. Illinois has prominence as a mining State because of its large production of coal. In the quantity of coal produced it ranks third among the States, being exceeded by Pennsylvania and West Virginia. In the value of the output, however, Illinois exceeds West Virginia by more dollars than West Virginia exceeds Illinois in the number of tons produced. The value of the coal produced in Illinois considerably exceeds 50 per cent of the total mineral production of the State. In 1912 the total value of the mineral production was $123,068,867, of which coal represented $70,294,338. In 1911 the value of all the minerals produced in the State was $106,275,115, of which the coal mines yielded $59,519,478. There are 102 counties in the State and coal is mined in 50, just about half of the total. The counties credited with the largest production are in the southern part of the State and in the

southwestern part, adjacent to the city of St. Louis, although in the northern part of the State, where the mines are closer to Chicago markets, large mining operations are carried on. The reason for the larger production in the southern part of the State seems to be that the beds in that section are thicker than those worked in the northern part, and moreover the Chicago market is one which to a considerable extent is supplied by West Virginia coal, and most of the coal used in the manufacture of coke at Chicago and Joliet is from West Virginia mines. Two counties—Sangamon, in the central part, and Williamson, in the southern part of the State—exceeded 5,000,000 tons of coal in both 1911 and 1912. Five other counties—Macoupin, in the central part, and Franklin, Madison, St. Clair, and Saline, in the southern part—had a production exceeding 4,000,000 tons in 1912, and one—Vermilion, in the eastern part—exceeded 3,000,000 tons. The most important producing counties in the northern part of Illinois are La Salle and Bureau, each of which produced a little over 1,500,000 tons in 1912. The total coal production of Illinois in 1912 was 59,885,226 short tons, an increase from 53,679,118 tons in 1911.

Illinois is also an important producer of coke, but at least 80 per cent of the raw coal used in the coke ovens comes from West Virginia. In the retort coke oven works at South Chicago and Joliet the charging mixture consists of approximately 80 per cent of West Virginia coal, with 20 per cent of Illinois coal.

Second in importance among Illinois mineral products is petroleum, the output of which in 1912 amounted to 28,601,308 barrels, valued at $24,332,605, a decrease in quantity from 31,317,038 barrels in 1911, and in value of nearly $4,600,000, from $19,734,339. Although the production of petroleum in appreciable quantity from Illinois is a part of the history of the last 10 years, the State now ranks third as a petroleum producer, and is the most important State in this regard east of the Mississippi River. Prior to 1905 the oil production of Illinois was measured by a few hundred barrels annually, but in the last six months of that year, owing to some developments near Casey, Clark County, the production rose to over 180,000 barrels. There was little thought of the importance to which Illinois would rise as a petroleum producer. Within the three years of the extension of the oil territory the production of the State jumped to over 33,000,000 barrels, and it has averaged over 30,000,000 barrels during the last five years. There has been some apprehension that the standing of Illinois as a petroleum producer would be shortlived. A decrease in the production has been indicated in both 1911 and 1912, and unless there is a considerable extension of producing territory this decline will continue. At present the principal petroleum producing counties in the State are Lawrence, Clark, Crawford, Clinton, Marion, and Cumberland. In 1912 a considerable development was made in Wabash County.

Some natural gas is produced in the State, but when compared with the output of coal and petroleum it is insignificant. The three fuels had a combined value in 1912 of $95,243,410, or 77.4 per cent of the total mineral value. In 1911 the fuel values were $79,941,543, or 75.2 per cent of the total.

Illinois is one of the leading States in the utilization of its clay resources. In the value of manufactured clay products it ranks fourth among the States, with a total in 1912 of $15,210,990, compared with $14,333,011 in 1911. The clay products might be made in any of the 102 counties of the State. The raw material is present everywhere and fuel is abundant and cheap. The clay-working industry is, however, concentrated in a large measure in the vicinity of Chicago, Cook County, and this district contributes over 40 per cent of the total for the State. Other important clay-producing counties are Lasalle, Knox, Livingston, Vermilion, and Kankakee, each of which had an output in excess of $500,000 during the last two years. The principal clay products of the State are building brick, vitrified brick, architectural terra cotta, drain tile, and pottery. In the value of its brick and tile products Illinois ranks third, and according to the Thirteenth Census of the United States it also ranks third in the value of its total manufactures.

There are four other mineral industries in Illinois which yield products in excess of a million dollars annually. These are cement (marketed production of Portland in 1912, 4,602,617 barrels, valued at $3,444,085), sand and gravel (production in 1912, 6,957,901 short tons, valued at $1,929,822), stone (total value in 1912, $3,841,504), and sulphuric acid (160,378 short tons in 1912, valued at $1,064,564).

The cement plants are located principally in the northern part of the State, convenient to the Chicago market and to water transportation on Lake Michigan. The principal quarry product is limestone, and Cook, Kankakee, Vermilion, and Will counties are the leading producers.

Illinois ranks first in the production of fluorspar, mined at Rosiclare, in the southern part of the State, and second in the production of "tripoli," a residual siliceous material used as a basis for abrasives and for filtration. Other mineral products of the State are asphalt, glass sand and other sands, gravel, lead, lime, mineral paints, mineral waters, pyrite (a by-product in coal mining), silver, and zinc.

The output of pig iron, which is not included in the total value, amounted to 2,036,081 long tons, valued at $31,152,927, in 1911, and 2,806,378 long tons, valued at $42,828,816, in 1912. In addition to the pig iron, ferroalloys amounting in total value to over $800,000 are made within the State. The figures of lead and silver production given in the following table are the quantity and value of the recoverable metallic content of the ores mined within the State. The statistics of production in the last two years are presented on the next page.

Mineral production of Illinois in 1911 and 1912.

Product.	1911			
	Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..			(a)	(a)
Briquets, fuel.....do....			(a) (b)	(a) (b)
Cement.....barrels..			c 4,582,341	c $3,583,301
Clay products.....short tons..	182,836	b $183,826		14,333,011
Coal.....do....	53,679,118	59,519,478		
Coke.....do....			1,610,212	b 6,390,251
Ferroalloys.....long tons..			(a) (b)	(a) (b)
Fluorspar.....short tons..	68,817	481,635		
Iron, pig.....long tons..			2,036,081	b 31,152,927
Lead.....short tons..			964	86,760
Lime.....do....			92,169	423,762
Mineral paints, zinc-lead pigments, short tons				
Mineral waters.....gallons sold..	1,304,950	82,330		
Natural gas		687,726		
Petroleum.....barrels..	31,317,038	19,734,339		
Pyrite.....long tons..	17,441	47,020		
Sand and gravel.....short tons..	8,488,683	1,990,922		
Silver.....fine ounces (troy)..			3,036	1,609
Stone		(d)		d 3,467,930
Sulphuric acid (60° Baumé), e short tons			144,805	958,591
Tripoli				45,910
Zinc.....short tons..			4,219	480,966
Miscellaneous				1,199,475
Total value, eliminating duplications	$106,275,115			

Product.	1912			
	Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..			(a)	(a)
Briquets, fuel.....do....			(a) (b)	(a) (b)
Cement.....barrels..			c 4,602,617	c $3,444,085
Clay products.....short tons..	176,558	b $192,663		15,210,990
Coal.....do....	59,885,226	70,294,338		
Coke.....do....			1,764,944	b 8,069,903
Ferroalloys.....long tons..			(a) (b)	(a) (b)
Fluorspar.....short tons..	(a)	(a)		
Iron, pig.....long tons..			2,806,378	b 42,828,816
Lead.....short tons..			1,282	115,380
Lime.....do....			98,450	394,892
Mineral paints, zinc-lead pigments, short tons			(a)	(a)
Mineral waters.....gallons sold..	1,143,625	74,445		
Natural gas		616,467		
Petroleum.....barrels..	28,601,308	24,332,605		
Pyrite.....long tons..	27,008	62,980		
Sand and gravel.....short tons..	6,957,901	1,929,822		
Silver.....fine ounces (troy)..			4,731	2,909
Stone		(d)		d 3,841,504
Sulphuric acid (60° Baumé), e short tons			160,378	1,064,564
Tripoli				27,339
Zinc.....short tons..			4,065	560,970
Miscellaneous		(d)		d 1,992,632
Total value, eliminating duplications	$123,068,867			

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of natural cement, value for which is included under "Miscellaneous."
d Raw product included in derived product.
e From zinc smelting.

INDIANA.

In Indiana, fourteenth among the States in mineral production, the principal products are coal, clay, cement, and stone, the aggregate value of these four substances being equal to nearly 90 per cent of the total value of the mineral products of the State. In 1912 the total value of the mineral products of Indiana was $42,239,193, and in 1911 it was $37,430,187. These values, however, do not include that of the pig iron produced in the State, which in 1912 exceeded $17,000,000. In the production of coal, which is the principal mineral product of the State, Indiana ranked seventh in 1912, with an output amounting to 15,285,718 short tons, valued at $17,480,546. In 1911 the production was 14,201,355 short tons, valued at $15,326,808. The coal-producing counties are all in the southwestern part of the State and embrace an area of approximately 6,500 square miles. The principal producing counties are Greene, Sullivan, and Vigo, the last two having an output in 1912 exceeding 3,000,000 tons each. Greene County's production in 1912 was about 2,600,000 tons. Only three other counties, Clay, Knox, and Vermilion, have produced as much as 1,000,000 tons a year.

The clay-working industries rank second in importance among Indiana's activities in mineral production, somewhat closely followed by cement. In 1912 the value of the clay products was $7,935,251 and the value of the Portland cement $7,237,591, which represented the value of 9,634,582 barrels produced. In 1911 the value of the clay products was $7,000,771, and that of the Portland cement (amounting to 7,407,830 barrels) $5,937,241. The leading counties in the manufacture of clay products are Clay, Lake, Vigo, Parke, and Madison. The principal clay products are draintile, building brick, and vitrified brick. The draintile works are mainly in Vermilion County. The under clay of the coal beds furnishes an excellent base for the manufacture of fire brick and encaustic tile. In the manufacture of encaustic tile Indiana ranks third among the States, plants for its manufacture being situated at or near Indianapolis.

The centers of cement manufacture are at Buffington, Stroh, and Syracuse in the northern part of the State, and at Mitchell and Speeds in the southern part. The principal quarry product of Indiana is limestone, less than 1 per cent of the total production being of other stone. The Bedford limestone quarried in Lawrence and Monroe Counties is highly prized for structural purposes, and is the principal stone product of the State.

Since the completion of the plant of 560 retort coke ovens by the United States Steel Corporation at Gary Indiana has assumed importance as a manufacturer of coke. In addition to the Gary plant there are 50 retort ovens at Indianapolis and 22 at Muncie. In 1912 Indiana took third place in the manufacture of coke, displacing West Virginia, Illinois, and Colorado. Its production of coke increased from a little over 900,000 short tons, valued at approximately $3,600,000, in 1911, to 2,616,339 short tons, valued at $12,528,685, in 1912. The coal for the Gary and Indianapolis ovens, like most of that consumed for coke making in Illinois, is derived from West Virginia mines.

The plant at Muncie, where gas for domestic consumption is the primary product, uses at the present time Youghiogheny gas coal. The value of the coke, like that of pig iron, is not included in the total.

The value of the natural gas produced in Indiana decreased from $1,192,418 in 1911 to $1,014,295 in 1912, and the output of petroleum decreased from 1,695,289 barrels, valued at $1,228,835, to 970,009 barrels, valued at $885,975. The sand and gravel beds yield products valued in excess of $1,000,000 annually, the output in 1912 being $1,175,370 against $1,133,829 in 1911. The other primary mineral products of the State are gems (occasionally), lime, mineral paints, mineral waters, oilstones, pyrite, sand-lime brick, and sulphuric acid from zinc smelting. The total value of the mineral products of the State in 1911 and 1912 is shown in the following table:

Mineral production of Indiana in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons			[a] [b]	[a] [b]			[a] [b]	[a] [b]
Cement...barrels			[c]7,407,830	[c]$5,937,241			[c]9,634,582	[c]$7,237,591
Clay products, short tons	61,992	[b]$54,918		7,000,771	82,035	[b]$71,391		7,935,251
Coal...short tons	14,201,355	15,326,808			15,285,718	17,480,546		
Coke.....do			[a] [b]	[a] [b]			2,616,339	[b]12,528,685
Gems and precious stones				20				100
Iron, pig, long tons			851,485	[b]12,772,275			[a] [b]	[a] [b]
Lime...short tons			92,229	324,950			98,086	329,893
Mineral paints, natural pigments, short tons			[a]	[a]			[a]	[a]
Mineral waters, gallons sold	1,084,428	653,641			993,163	677,718		
Natural gas		1,192,418				1,014,295		
Oilstones				18,151				19,715
Petroleum, barrels	1,695,289	1,228,835			970,009	885,975		
Pyrite..long tons	[a]	[a]			1,462	5,684		
Sand and gravel, short tons	6,033,159	1,133,829			4,701,005	1,175,370		
Sand-lime brick				45,891				59,929
Stone		[d]		[d]4,413,655		[d]		[d]5,091,924
Sulphuric acid (60° Baumé)[e], short tons			[a]	[a]			[a]	[a]
Miscellaneous		[d]		[d]3,779,172				17,495,437
Total value, eliminating duplications	$37,430,187				$42,239,193			

[a] Value included under "Miscellaneous."
[b] Value not included in total value.
[c] Exclusive of natural cement, value for which is included under "Miscellaneous."
[d] Raw product included in derived product.
[e] From zinc smelting.

IOWA.

The principal mining industries of Iowa are coal mining and clay working, these two contributing about 77 per cent of the total mineral

value, which amounted to $22,900,350 in 1912, against $21,112,896 in 1911. The value of the total mineral output in 1912 is the highest ever made. Over 60 per cent of the value is represented by the output of the coal mines, which in 1912 amounted to 7,289,529 short tons, valued at $13,152,088, against 7,331,648 short tons, valued at $12,663,507, in 1911. Coal is mined in 22 different counties, of which the principal ones are Monroe, Polk, Appanoose, Mahaska, and Dallas, in the order named. The coal-mining operations are conducted chiefly on a moderate scale, there being but 25 mines with a production in excess of 100,000 tons and only 4 with a production of over 200,000 tons. Iowa ranks eleventh among the States in the production of coal, third among the States west of Mississippi River, and was probably the second State west of the river in priority as a coal producer, the production dating back to 1840, but the industry in this State has not shown the same progress as in many of the other Western States. In the 30 years that reports on mineral production have been published by the United States Geological Survey, or since 1882, the coal production of Iowa has increased barely 100 per cent, there being but one year (1910) when the output was double that of 1882, whereas the total production of coal in the Western States in 1912 was about 10 times that of the earlier year. The reason for this probably lies in the fact that Iowa is largely an agricultural State and manufactures have not been thoroughly developed. It ranks eighteenth in the value of its manufactures and twentieth in its mineral output.

The value of the clay products of Iowa in 1912 was $4,522,326, against $4,432,874 in 1911. The chief products are draintile, in which Iowa holds first place among the States, and common brick. The principal producing counties are Webster, Cerro Gordo, Polk, and Woodbury. Third in importance among the State's mining industries is the manufacture of Portland cement, the marketed product of which in 1912 showed an increase of 63 per cent in quantity and nearly 50 per cent in value over 1911, the figures being 1,952,590 barrels, valued at $1,881,253, in 1911, and 3,190,354 barrels, valued at $2,790,396, in 1912. The State has three modern cement plants of large capacity and possesses an abundant quantity of excellent raw material for cement manufacture. Notable increases were also made in the production of stone and of sand and gravel, the former from $736,207 in 1911 to $946,436 in 1912, and the latter from $393,649 to $562,809. These increases were due largely to the demand for stone (principally limestone) by the Mississippi Power Co. for use in the construction of the Keokuk Dam. Lee County produced more than one-third of the State's total output of stone in 1912. Most of the stone produced is used in the manufacture of concrete and for railroad ballast.

The branch of the mining industry in which Iowa ranks relatively high is in the production of gypsum, holding second place among the States. The value of the gypsum products in 1912 amounted to $845,628, against $871,752 in 1911. The other commercial mineral products are lead, lime, mineral paints, mineral waters, and sand-lime brick, with a small amount of natural gas.

The production of the different minerals in 1911 and 1912, so far as they may be published separately, was as follows:

Mineral production of Iowa in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Cement.....barrels	.....	.....	1,952,590	$1,881,253	.....	.....	3,190,354	$2,790,396
Clay products, short tons	9,643	b $3,965	.....	4,432,874	7,192	b $2,166	.....	4,522,326
Coal.....short tons	7,331,648	12,663,507	.....	.....	7,289,529	13,152,088	.....	.....
Gypsum.....do	354,204	.....	.....	871,752	411,186	.....	.....	845,628
Lead.....do	.....	.....	60	5,400	.....	.....	63	5,670
Lime.....do	.....	.....	14,791	80,914	.....	.....	12,935	51,800
Mineral paints, natural pigments...short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold	176,000	20,500	.....	.....	84,300	11,375	.....	.....
Natural gas	.....	70	.....	.....	.....	120	.....	.....
Sand and gravel, short tons	1,349,004	393,649	.....	.....	2,231,615	562,809	.....	.....
Sand-lime brick	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone	.....	(c)	.....	c 736,207	.....	(c)	.....	c 946,436
Miscellaneous	.....	.....	.....	27,970	.....	.....	.....	13,702
Total value, eliminating duplications		$21,112,896				$22,900,350		

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

KANSAS.

The two principal mineral products of Kansas are fuels—coal and natural gas—which constitute nearly 60 per cent of the value of the minerals produced in the State. Some petroleum is also produced, but it falls behind cement, clay products, and zinc in the value of output. The coal-producing area is entirely in the eastern part of the State, and the two leading counties, Cherokee and Crawford (credited with more than 90 per cent of the total), are in the extreme southeast corner. The principal counties in the production of natural gas are Montgomery and Wilson, also in the southeastern part of the State. The development of the gas resources of Kansas is largely a part of the history of the last decade, for although some gas was produced in the State as early as 1886, it did not assume any importance until 1901, when the value amounted to about $660,000. In 1911 the value of the natural gas produced in Kansas was $4,854,534; in 1912 it declined to $4,264,706, which was a little more than half of the value of the gas produced in 1909, the year of maximum production. The deficiency in the gas production of Kansas during the last two years has been made up by the gas drawn from Oklahoma. The coal production of Kansas in 1912 amounted to 6,986,182 short tons, valued at $11,324,130, an increase of over 800,000 tons in quantity and of nearly $2,000,000 in value over 1911, but less than the output of 1907, when the maximum tonnage was mined, by about 336,000 tons. In value

the production of 1912, however, exceeded that of 1907 by over $160,000. The manufacture of cement has followed somewhat the production of natural gas, the cement industry having been developed because of the cheap, abundant supply of natural gas. The highest point in the production of natural gas was reached in 1909, and since that year it has declined. The year of maximum production of cement was 1910, when the output of Portland cement amounted to 5,655,808 barrels, valued at $5,359,408, the declining tendency in the output of natural gas, which began in 1910, not being sufficiently marked to affect the production of cement. The value of the gas production has declined from $8,293,846 in 1909 to $4,264,706 in 1912. The decline in quantity was even more marked—from 75,000,000,000 cubic feet in 1909 to 28,000,000,000 cubic feet in 1912. The average value per thousand cubic feet of the gas produced in Kansas was 11.05 cents in 1909 and 15.19 cents in 1912. The production of Portland cement decreased from 5,655,808 barrels, valued at $5,359,408, in 1910, to 3,592,148 barrels, valued at $2,815,113, in 1912. A small amount of natural cement is also made in the State.

The value of the clay products has also declined in each of the last two years, although not to the same extent as that of cement. In 1910 the value of the clay products, exclusive of pottery, was $2,661,527; it decreased to $2,360,262 in 1911 and to $2,036,500 in 1912. The principal product from the clay-burning kilns is vitrified brick, in the production of which Kansas ranks fourth among the States. The average price of this brick in Kansas in 1912 was $9.97 a thousand, $2 less than the average price for this kind of brick in the United States and the lowest average price for all the States, with the exception of Arkansas, Kentucky, and Oklahoma. The principal counties in the manufacture of vitrified brick are Wilson, Montgomery, and Crawford. Wilson County is also the largest producer of common brick, Montgomery second, and Allen third.

Fifth among the mining industries of Kansas is the production of zinc ores, the recoverable metallic content of which increased from 10,272 short tons, valued at $1,171,008, in 1911, to 10,633 short tons, valued at $1,467,354, in 1912.

Other important mineral industries in Kansas are salt mining and evaporating, stone quarrying, and the mining and calcining of gypsum. In the production of salt Kansas ranks fourth among the States, and in zinc it stands sixth. Less important mineral products of Kansas are lead, lime, mineral waters, pumice, sand and gravel, sand-lime brick, sulphuric acid from zinc smelting, and zinc and lead pigments. The total value of the mineral products of Kansas in 1912 was $26,554,967, against $25,237,043 in 1911, distributed by substances as shown in the following table:

Mineral production of Kansas in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement...barrels..	.....	.....	[a] 4,871,903	[a] $3,725,108	.....	.....	[a] 3,592,148	[a] $2,815,113
Clay products.....	.....	.....	.....	[b] 2,360,262	.....	.....	.....	[b] 2,036,500
Coal...short tons..	6,178,728	$9,473,572	.....	.....	6,986,182	$11,324,130	.....	.....
Coke.....do.....	.....	.....	[c] [d]	[c] [d]	.....	.....	[c] [d]	[c] [d]
Gypsum....do.....	122,579	.....	.....	319,504	131,031	.....	.....	324,820
Lead.....do.....	.....	.....	2,859	257,310	.....	.....	2,371	213,390
Lime.....do.....	.....	.....	648	3,440	.....	.....	232	1,131
Mineral paints, zinc-lead pigments.....do.....	.....	.....	[c]	[c]	.....	.....	[c]	[c]
Mineral waters, gallons sold.....	456,341	63,063	.....	.....	428,677	75,919	.....	.....
Natural gas.....	.....	4,854,534	.....	.....	.....	4,264,706	.....	.....
Petroleum, barrels.....	1,278,819	608,756	.....	.....	1,592,796	1,095,698	.....	.....
Pumice, short tons.....	[c]	[c]	.....	.....	[c]	[c]	.....	.....
Salt.....barrels..	769,691	197,361	1,390,168	608,666	1,244,014	229,805	1,329,612	614,487
Sand and gravel, short tons.....	734,507	164,058	.....	.....	1,381,586	287,352	.....	.....
Sand-lime brick...	.....	.....	.....	[c]	.....	.....	.....	[c]
Stone.....	.....	[c]	.....	[e] 803,222	.....	[e]	.....	[e] 763,228
Sulphuric acid (60° Baumé) [f], short tons.....	.....	.....	[c]	[c]	.....	.....	[c]	[c]
Zinc.....do.....	.....	.....	10,272	1,171,008	.....	.....	10,633	1,467,354
Miscellaneous.....	.....	[e]	.....	[e] 629,104	.....	[e]	.....	[e] 1,044,209
Total value, eliminating duplications....	$25,237,043				$26,554,967			

[a] Exclusive of natural cement, value for which is included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Value not included in total value.
[e] Raw product included in derived product.
[f] From zinc smelting.

KENTUCKY.

The principal mineral product of Kentucky is coal, the value of which constitutes about three-fourths of the State's total mineral output. In 1911 the total value of Kentucky's mineral production was $19,296,614, of which the coal output made up $14,008,458, and in 1912 out of $22,452,984 the coal mines contributed $16,854,207. The coal-producing areas of Kentucky are in the extreme eastern counties and in the more northern counties in the western part of the State. The coal beds in the eastern part of the State belong to the Appalachian system, whereas those in the western part of the State belong to the eastern interior field, the larger part of which lies across Ohio River in Illinois and Indiana on the north. The production has been almost evenly divided between the two sections, the western area having somewhat the better of it up to the close of 1911. In 1912 the influence of extensive developments in Harlan, Johnson, Letcher, and Pike counties, in the eastern part of the State, resulted in a

marked increase in that section and for the first time the total production of the eastern counties exceeded that of the western counties. There is little probability that the western district will again obtain the supremacy. The principal producing counties in the eastern part of the State are Bell, Pike, Whitley, Johnson, and Knox, and the largest producers in the western district are Hopkins, Muhlenberg, Webster, Ohio, and Union counties. In 1912 the eastern counties produced 8,617,193 short tons, against 6,889,162 short tons in 1911, and the western counties produce 7,873,328 tons in 1912, against 7,160,541 tons in 1911.

The clay-working industry is second in importance in the State, with manufactured products in 1912 valued at $2,443,740, against $2,368,094 in 1911. The principal clay products are fire brick and other forms of refractory material made from fire clay, and common brick. The principal producing counties are Jefferson, Carter, Kenton, and Boyd. Potter's clay occurs in Madison, Fulton, and Hickman counties. Ball clay is produced in Graves County. The total quantity of raw clay produced was 91,097 short tons, valued at $93,560, in 1912, against 131,808 short tons, valued at $126,457, in 1911.

The quarrying industry is third in importance and the principal product is limestone, most of which is crushed for road making, railroad ballast, and concrete. The principal limestone-producing counties are Warren, Christian, Jefferson, Rockcastle, Caldwell, and Jessamine. Rowan and Rockcastle counties are the principal producers of free stone. The total production of stone in Kentucky reported to the Survey in 1912 was valued at $1,282,148, against $1,227,609 in 1911.

The value of the natural gas produced in Kentucky was $497,909 in 1912 and $407,689 in 1911. The value of the petroleum produced in the State in 1912 was $424,842, and in 1911, $328,614, from Barren, Bath, Floyd, Knott, Lawrence, Logan, Ohio, Rowan, Wayne, and Wolfe counties. Kentucky is second among the States in the production of fluorspar, which is mined in Crittenden and Livingston counties. Some barytes has been produced in Boyle, Jessamine, Fayette, Garrard, and Lincoln counties, but no output of this substance was reported in 1912. The other mineral products of the State are asphalt, cement, iron ore, lead, lime, mineral paints, mineral waters, oilstones, sand and gravel, sand-lime brick, and zinc. A small amount of silver has been produced in the State, but none was reported in 1911 or 1912. A small amount of lithographic stone at Brandenberg, Meade County, was produced in 1911 and 1912, and some calcite is mined in Mercer County.

The total value of the mineral products of Kentucky was $22,452,984 in 1912, against $19,296,614 in 1911. The statistics of the mineral production in 1911 and 1912 by substances are given in the following table:

Mineral production of Kentucky in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Barytes.....do....	(a)	(a)	.....	.....	.....	.....	.....	.....
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	131,808	b $126,457	.....	$2,368,094	91,097	b $93,560	.....	$2,443,740
Coal.....short tons..	14,049,703	14,008,458	.....	.....	16,490,521	16,854,207	.....	.....
Coke.....do....	.....	.....	66,099	b 134,862	.....	.....	191,555	b 513,734
Ferro-alloys...long tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Fluorspar....short tons..	12,403	96,574	.....	.....	(a)	(a)	.....	.....
Iron ore.....long tons..	63,770	78,212	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do....	.....	.....	57,982	b 870,542	.....	.....	77,578	b1,221,161
Lead.....short tons..	.....	.....	.....	.....	.....	.....	106	9,540
Lime.....do....	.....	.....	4,365	15,121	.....	.....	3,397	11,577
Mineral paints, natural pigments..short tons..	.....	.....	(a)	(a)	.....	.....	.....	.....
Mineral waters, gallons sold.....	423,729	49,827	.....	.....	477,341	56,555	.....	.....
Natural gas.....	.....	407,689	.....	.....	.....	497,909	.....	.....
Oilstones.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Petroleum.....barrels..	472,458	328,614	.....	.....	484,368	424,842	.....	.....
Phosphate rock, long tons.....	(a)	(a)	.....	.....	.....	.....	.....	.....
Sand and gravel, short tons.....	906,905	389,568	.....	.....	778,241	391,477	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone.....	.....	(c)	.....	c1,227,609	.....	(c)	.....	c1,282,148
Zinc.....short tons..	.....	.....	158	18,012	.....	.....	491	67,758
Miscellaneous.....	.....	35,095	.....	704,779	.....	109,307	.....	1,044,839
Total value, eliminating duplications.....	$19,296,614				$22,452,984			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

LOUISIANA.

In one respect Louisiana stands preeminently in the lead of the States of the Union—that is, in the production of sulphur. In 1904 the Frasch process for the recovery of sulphur from beds underlying a heavy cover of quicksand was put into operation by the Union Sulphur Co., of Sulphur City, about 12 miles west of Lake Charles, in Calcasieu Parish. Since that time approximately 2,330,000 tons of refined sulphur have been recovered. Prior to 1904 the only domestic source of sulphur in quantity in the United States was iron pyrite, from which sulphuric acid is made direct, and nearly all the sulphur used was imported from Sicily. At the present time the domestic output of refined sulphur, except from Louisiana, is a negligible quantity, and the quantity and value of the imports are insignificant compared with what they were 10 years ago. In 1903, one year before the production of sulphur in Louisiana began to exert an influence upon the market the imports of sulphur (crude and refined) into the United States amounted to 191,033 long tons, valued at $3,709,690. In 1912 the imports amounted to 29,927 tons, valued at $583,974. The domestic production of sulphur in 1912 exceeded by more than

145,000 tons, or nearly 50 per cent, the imports of Sicilian sulphur in 1903, and was more than ten times the imports of sulphur in 1912. While Louisiana has almost a practical monopoly in the production of sulphur in this country, that substance is not the chief source of the mineral wealth of the State. Two years before the development of the sulphur resources at Sulphur City prospecting for petroleum in Louisiana, which had followed the sensational strike of oil at Beaumont, Tex., in 1901, resulted in the discovery and development of several oil pools in the vicinity of Jennings, La. Since that time productive areas have been developed in several portions of the State, and Louisiana now ranks sixth among the States in the quantity of oil produced and eighth in the value of the product. In the first two years of oil development the production did not amount to 1,000,000 barrels each year, but in 1904, the year in which the sulphur industry asserted itself, the output of petroleum approximated 3,000,000 barrels, and in 1905 that output was trebled. The maximum production of petroleum was reached in 1911, when 10,720,420 barrels, valued at $5,668,814, were reported. In 1912 the quantity decreased to 9,263,439 barrels, but the value increased to $7,023,827. The larger part of the production is obtained from the Caddo district, near Shreveport, in the northwestern portion of Louisiana, and from Acadia and Calcasieu parishes, in the southwestern part of the State. The combined value of the petroleum and sulphur products of Louisiana is nearly 90 per cent of the State's total mineral value, so that it may be considered that it is only during the last 10 years that Louisiana has developed into any prominence as a mineral-producing State. In addition to petroleum and sulphur, Louisiana is also an important producer of rock salt, in which it ranks second among the States. The salt mines underlie so-called islands which are really mounds rising above the marsh lands along the Gulf shore in Iberia Parish. The Petite Anse mines on Avery Island were operated during the Civil War, having been developed in a small way in 1862. These mines were flooded twice, and a new shaft was sunk in 1899. Mining on Weeks Island began in 1902. In the total production of salt, which includes the product evaporated from brine, Louisiana ranks sixth as to value among the States. The value of the natural gas produced in Louisiana in 1912, the development of this resource having followed that of petroleum, was more than 100 per cent greater than that of the production in 1911. There is good reason to believe that Louisiana is underlain by one of the greatest gas fields in the United States, and it is practically certain that in the last two years more gas has been wasted in the petroleum and gas fields of Louisiana than in any other State in which those resources have been developed.

Louisiana's clay products, exclusive of pottery, were valued at $523,643 in 1912, against $531,949 in 1911. The principal clay product is common brick. The gravel pits of the State yielded 933,617 short tons, valued at $417,041 in 1912, a decrease in quantity from 969,259 short tons in 1911, but an increase in value from $344,281. The only other mineral products are mineral waters and a small amount of stone.

The mineral production of the State in 1911 and 1912 is shown in the following table:

Mineral production of Louisiana in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				[a] $531,949				[a] $523,643
Mineral waters, gallons sold	1,520,550	$110,998			561,660	$33,345		
Natural gas		[b]				[b]		
Petroleum, barrels	10,720,420	5,668,814			9,263,439	7,023,827		
Salt, do	[b]	[b]			[b]	[b]		
Sand and gravel, short tons	969,259	344,281			933,617	417,041		
Stone		[c]		[b]		[c]		[b]
Sulphur, long tons	[b]	[b]			[b]	[b]		
Miscellaneous		5,953,897		101,019		7,289,753		70,232
Total value, eliminating duplications	$12,710,958				$15,357,841			

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Stone sold rough included in derived product.

MAINE.

Maine does not claim much distinction as a mineral-producing State, having a total output in 1912 valued at less than $4,000,000 and ranking thirty-ninth among all the States in mineral production. In the value of production of one mineral substance, feldspar, Maine ranked first in 1912 and in 1911, although feldspar is not the most important item of the State's mineral output. It is mined in Androscoggin, Oxford, and Sagadahoc counties. The principal product of the State is granite, in which it ranks third among the States, being exceeded only by Vermont and Massachusetts. More than half of the granite is used for building and monumental purposes, but considerable quantities are made into paving blocks and curbing, and a relatively small quantity, chiefly waste, is used for road making, concrete, railroad ballast, and miscellaneous purposes. Maine also produced some limestone, most of which, exclusive of that burned for lime in the State, was reported as used by paper manufacturers. The granite quarries contributed approximately one-half of the total mineral production of the State. They are located principally in Franklin, Hancock, Kennebec, Knox, and Waldo counties. The State's stone production was valued at $2,263,200 in 1911 and $1,810,590 in 1912. Maine is also one of the leading States in the production of slate, which is quarried in Piscataquis County. The slate product was valued at $282,678 in 1912, against $263,516 in 1911. Maine ranked fifth in quantity and seventh in value in 1912 in the production of lime, which was valued at $644,255, a decrease from $773,212 in 1911. The only other commercial minerals produced in the State in 1912 were clay (manufactured products), valued at $540,101; gem materials, valued at $15,100; mineral waters, valued at $432,765; and sand and gravel, valued at $26,961.

The total value of the mineral products of Maine in 1911 and 1912 was, respectively, $4,645,630 and $3,925,526, distributed by substances as shown in the following table:

Mineral production of Maine in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				$625,214				$540,101
Feldspar, short tons	25,976	$246,305			19,091	$173,076		
Gems and precious stones				12,355				15,100
Lime, short tons			152,552	773,212			155,559	644,255
Mineral waters, gallons sold	1,254,783	431,740			1,179,192	432,765		
Sand and gravel, short tons	33,308	30,088			34,372	26,961		
Slate				263,516				282,678
Stone		(a)		a2,263,200		(a)		a1,810,590
Total value, eliminating duplications	$4,645,630				$3,925,526			

a Stone sold rough included in derived product.

MARYLAND.

The principal mineral product of Maryland is coal, mined in Allegany and Garrett counties, in the western part of the State. The value of the output of coal in Maryland represents over one-half of the State's total mineral value. Coal mining in Maryland began early in the first quarter of the nineteenth century, in the Georges Creek region, and the coal was shipped by barges on Potomac River. The first incorporated company was organized in 1836. The Cumberland "big vein," noted for its high-grade steaming and smithing quality, has furnished most of the coal produced in the State. The long draft upon the resources of this famous bed, however, has resulted in its practical depletion; and while coal will be mined from the "big vein" for some years to come, it is probable that the principal production in the future must come from the lower and thinner beds. That this condition is realized by the larger interests in indicated by the recent investments of the Consolidation Coal Co., of Baltimore, in Johnson and Letcher Counties, Ky., and the extensive developments already accomplished in that section. The coal-mining industry in Maryland has remained practically stationary during the last 10 years. The average annual production from 1903 to 1912 was about 4,900,000 tons. The output in 1912 was 4,964,038 short tons, valued at $5,839,079. In 1911 the production was 4,685,795 short tons, with a value of $5,197,066.

Next to coal, the most important mining industries in Maryland are clay working and stone quarrying. The clays of Maryland are widely distributed and are suitable for a variety of uses. In the Coastal Plain part of the State the clays are largely used for the manufacture of building brick and terra cotta. In the western part of the State the Carboniferous clays are used in the manufacture of fire brick, which are regarded among the highest grades made in the United States. The value of the common brick, manufactured

largely in the vicinity of Baltimore, in 1912 was $1,053,335, out of a total value for clay products of $1,865,753. The value of the fire brick was $262,817. The principal quarry product is granite, the quarries being located in Baltimore, Cecil, Harford, Howard, and Montgomery and Baltimore City counties. Baltimore County also produces a white marble, extensively used for structural purposes in the city of Baltimore. Limestone is produced in considerable quantities in the western part of the State. Exclusive of slate, the quarry products were valued at $1,097,022 in 1912, against $1,133,339 in 1911. A part of the Peach Bottom slate belt is found in Harford County, and considerable operations are carried on, the production of slate in 1912 being valued at $92,184. The production of lime amounted to 112,104 short tons, valued at $365,037, in 1912, against 114,386 short tons, valued at $362,839, in 1911.

One of the most notable increases in production was in the output of sand and gravel, which showed a gain from 482,152 short tons, valued at $246,486, in 1911, to 1,650,904 short tons, valued at $627,874, in 1912.

The other commercial mineral products of Maryland are cement, copper, feldspar, infusorial earth, iron ore, mineral paints, mineral waters, quartz, sand-lime brick, talc and soapstone, and a small quantity of silver. The total value of the mineral products of Maryland was $9,386,515 in 1911 and $10,916,671 in 1912. If the value of the pig iron produced in the State were included, these totals would be increased by approximately 40 per cent. This distribution of Maryland's mineral products, by substances, in 1911 and 1912, is shown in the following table:

Mineral production of Maryland in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel....short tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products....short tons..	12,323	b $28,123	.....	$1,772,434	25,279	b $36,687	.....	$1,865,753
Coal.....do....	4,685,795	5,197,066	.....	.....	4,964,038	5,839,079	.....	.....
Coke.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Copper.....pounds..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Feldspar.....short tons..	12,694	56,265	.....	.....	9,231	55,998	.....	.....
Infusorial earth.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Iron ore.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do....	.....	.....	222,420	b3,467,789	.....	.....	(a) (b)	(a) (b)
Lime.....short tons..	.....	.....	114,386	362,839	.....	.....	112,104	365,037
Mineral paints, natural pigments.....short tons..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters..gallons sold..	1,657,756	150,966	.....	.....	1,606,373	157,541	.....	.....
Quartz.....short tons..	7,977	34,286	.....	.....	16,125	62,151	.....	.....
Sand and gravel.....do....	482,152	246,486	.....	.....	1,650,904	627,874	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver....fine ounces (troy)..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Slate.....	.....	.....	.....	76,035	.....	.....	.....	92,184
Stone.....	.....	(c)	.....	c1,133,339	.....	(c)	.....	c1,097,022
Talc and soapstone, short tons.	.....	.....	(a)	(a)	(c)	(c)	(a)	(a)
Miscellaneous.....	.....	(c)	.....	c1,707,013	.....	(c)	.....	c6,490,432
Total value, eliminating duplications.....	$9,386,515				$10,916,671			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

MASSACHUSETTS.

Massachusetts is not of much importance as a mineral-producing State. The principal mineral products are from the quarries and the clay pits. More than one-half of the total value of the mineral production is from the stone quarries, exclusive of the limestone burned into lime. The clay products furnish approximately 25 per cent of the total production and lime nearly half as much as the clay pits. In 1912 the combined total value of the stone, clay products, and the lime was $6,169,042, or 93 per cent of the total. About 60 per cent of the stone quarried, measured by value, was granite. The principal producing counties are Bristol, Essex, Middlesex, Norfolk, and Worcester. The granite quarried in Massachusetts is used principally for building and monumental purposes and for paving blocks. A relatively small quantity, principally the waste from the quarrying and stone-cutting operations, is used for road making, railroad ballast, and concrete. The quarrying of trap rock is next to that of granite in the value of the output, Massachusetts being one of the half-dozen States in which the production of trap rock is an important industry. The value of the output in 1912 was about 40 per cent of that of granite. This rock is obtained principally in Essex, Hampden, Middlesex, and Suffolk counties. Sandstone is quarried in Bristol, Hampden, and Suffolk counties, and marble in Berkshire and Hampden counties. The total value of the stone produced in Massachusetts in 1912 was $3,663,279, compared with $3,691,747 in 1911.

The principal clay products are common brick and brick for stove lining, and the principal counties producing common brick are Middlesex, Hampden, and Hampshire, in the order named, these three counties furnishing more than half the total number of common brick made in the State. The manufacture of stove lining is practically confined to Bristol County.

The lime-burning industry is located in Berkshire County and is carried on independently of the marble-quarrying operations, but it is probable that a considerable quantity of the waste from marble quarrying finds its way to the limekiln. The production of lime in Massachusetts increased from 137,440 short tons, valued at $695,662 in 1911 to 144,384 short tons, valued at $738,597 in 1912. Massachusetts ranks seventh among the States in the quantity of lime produced (fourth in value of production), and is eighth in the total production of stone.

The production of sand and gravel in Massachusetts amounted to 424,375 short tons, valued at $162,208 in 1912, against 374,326 short tons, valued at $222,822 in 1911.

Massachusetts does not produce any kind of mineral fuel, and its metal production is confined to a small output of iron ore. With the exception of a considerable output of mineral waters, the mineral substances produced are those which are largely used for structural work. In addition to the substances mentioned above, Massachusetts produced emery, fuller's earth, gems, infusorial earth, quartz, sand-lime brick, and talc. The total value of the mineral production of Massachusetts in 1912 was $6,654,514, against $6,623,077 in 1911,

the distribution by substances being as shown in the following table:

Mineral production of Massachusetts in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.short tons.	1,187	a $2,972	.....	$1,700,287	1,350	a $2,678	.....	$1,767,166
Coke.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Emery.....do....	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Fuller's earth.....do....	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Gems and precious stones.	.....	.....	.....	850	.....	.....	.....	700
Infusorial earth.....	.....	.....	.....	(b)	.....	.....	.....	(b)
Iron ore.....long tons..	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Iron, pig.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lime.....short tons..	.....	.....	137,440	695,662	.....	.....	144,384	738,597
Mineral waters, gallons sold.....	4,610,474	218,870	.....	.....	4,502,806	247,397	.....	.....
Pyrite.....long tons..	(b)	(b)	.....	.....	.....	.....	.....	.....
Quartz.....short tons..	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Sand and gravel...do....	374,326	222,822	.....	.....	424,375	162,208	.....	.....
Sand-lime brick.....	.....	.....	.....	(b)	.....	.....	.....	(b)
Stone.....	.....	(c)	.....	c3,691,747	.....	(c)	.....	c3,663,279
Talc.....short tons..	(c)	(c)	c7,642	c36,883	.....	.....	(b)	(b)
Miscellaneous.....	.....	51,441	.....	1,521,341	.....	34,054	.....	1,768,138
Total value, eliminating duplications.....	$6,623,077				$6,654,514			

a Value not included in total value.
b Value included under "Miscellaneous."
c Raw product included in derived product.

MICHIGAN.

Michigan, sixth among the States in the value of its mineral production, owes its prominence to its great wealth in two metals—copper and iron. It ranks second in the production of iron ore, being exceeded by Minnesota, and third in the production of copper, being exceeded by Arizona and Montana. With reference to the less important branches of the mining industry it ranks first in the production of salt, bromine, calcium chloride, graphite, and sand-lime brick, second in the production of grindstones, and fourth in the production of gypsum. In 1910, the total value of the production considered, the mining of iron ore was the leading industry in Michigan, but in 1911 and 1912 the value of the recoverable metallic content of the copper ores produced in the State exceeded the value of the iron ore mined. In the earlier year (1910) the iron-ore production of Michigan was 13,303,906 long tons, valued at $41,393,585. The slump in the iron trade of 1911 reduced the production of ore in the State to 8,945,103 long tons, valued at $23,810,710, and was not entirely overcome by the improved conditions in 1912, when the production amounted to 12,797,468 long tons, valued at $29,003,163. The value of the iron ore produced in Michigan in 1910 was nearly 50 per cent of the value of the total mineral output, and in 1912 it was 36 per cent. The iron ores of Michigan, as of the other two States included in the Lake Superior region (Minnesota and Wisconsin), are hematites of Bessemer grade. They occur in the Marquette range, all of

which is in Michigan, and the Menominee and Gogebic ranges, the larger portions of which are in Michigan and smaller portions in Wisconsin. The principal producing counties are Marquette, Iron, Gogebic, and Dickinson; a relatively small quantity comes from Baraga County.

In 1882, the first year for which the volume of Mineral Resources was published, the Marquette and Menominee ranges were the only ones opened in the Lake Superior region. The production in the region in that year was a little short of 3,000,000 long tons, most of which was from Michigan. The Crystal Falls and Iron River districts began production in 1882, the first year covered by this review. These are not as important producers as the better-known ranges, but each one is still turning out over a million tons yearly. The Gogebic range was opened in 1884, as was also the Vermilion range, in Minnesota. The Mesabi range, in Minnesota, now the greatest iron producer of the world, was opened in 1892, but Michigan continued to lead in the production of iron ore until the first year of the present century, its supremacy ceasing with 1900. At the present time two-thirds of the iron ore produced in the Lake Superior region is from the Mesabi range in Minnesota. A special chapter on the iron-ore reserves of Michigan, by C. K. Leith, was published in Mineral Resources for 1911.

The copper production of Michigan, the value of which in the last two years exceeded that of the iron-ore output, amounted in 1912 to 218,138,408 pounds, valued at $35,992,837, a decrease in quantity from 219,840,201 pounds in 1911, but an increase in value of over $8,000,000, from $27,480,013. The value of the copper produced was 45 per cent of the value of the State's total mineral output in 1912, and 42 per cent in 1911. The total mine production of copper in the United States in 1912 was 1,249,094,891 pounds, of which Michigan contributed 218,138,408 pounds, or 17 per cent. "Lake" copper, of which Michigan is the only producer, is largely native and is considered for some purposes superior to "electrolytic" copper. It usually sells at about one-fourth cent per pound above other coppers. The mining of copper in Michigan is of prehistoric origin, the metal having been used by the North American Indians before the advent of the white man. The records since 1845, or for a little more than 65 years, show that the total production of copper in Michigan from that date to the close of 1912 has amounted to over 5,200,000,000 pounds, about 30 per cent of the total output of the United States.

Michigan stands well up among the States in the manufacture of cement, which is third in value among the State's industries. The production has not materially changed during the last three years, having been 3,687,719 barrels in 1910, 3,686,716 barrels in 1911, and 3,494,621 barrels in 1912. The marketed production (or shipments) in 1912 was about 35,000 barrels less than the production in 1911, but the value showed a slight increase, from $3,024,676 to $3,145,001.

In the value of production of salt Michigan and New York have frequently alternated as first in rank, Michigan having held place of honor in 1911 and 1912. The salt works of the State were formerly by-plants of the lumber industry, using the sawmill waste for fuel. The decline in the lumber industry and the scarcity of wood for fuel have probably caused the salt works to turn to coal as a fuel and thereby influenced the coal production of the State. The salt pro-

duction of Michigan (exclusive of rock salt) amounted to 10,271,715 barrels, valued at $2,743,389 in 1912, against 9,766,410 barrels, valued at $2,455,983 in 1911. In the days when salt making was subsidiary to the lumber industry the plants were largely located along the lake shore in Bay and Saginaw counties. The lake shore plants have disappeared, but salt making is to a considerable extent still subsidiary to other industries where lumber is still the primary industry in and about Manistee and Ludington and on the shores of Lake Michigan. Bay and Saginaw counties, which were formerly of such importance on the shores of Saginaw Bay in the eastern part of the State, are now relatively insignificant. The principal producing districts are in St. Clair, Wayne, and Isabella counties. Some of the larger plants are subsidiaries of chemical companies.

The coal fields of Michigan occupy an isolated area in the Lower Peninsula. It is only within the last 12 years that they have been developed to any extent, and such importance as the industry has is due to the decline of the lumber industry, as stated above. In the earlier years the refuse of the lumber mills furnished the principal fuel for the salt works, but the exhaustion of the forests and the decline of the lumber industry has created a demand for coal to supply the salt works and for the other manufacturing plants of the State. The production of coal in Michigan, however, has shown a declining tendency during the last five years because of the competition of higher grade fuel from Pennsylvania and West Virginia. The maximum production of coal in Michigan was in 1907, when 2,035,858 tons were produced. It has decreased each year until in 1912 the production amounted to only 1,206,230 tons. The value has shown even more pronounced decline, principally because the use of automatic stokers by the manufacturing industries of the State include the utilization of coal "fines," and operators have had considerable difficulty in securing markets for the lump and better grades of coal.

There are two plants of by-product coke ovens in Michigan, one at Detroit and the other at Wyandotte, but the coal for both of these plants is obtained from the mines of West Virginia.

The principal clay products of Michigan are common brick and drain tile, and the leading counties are Wayne, Eaton, Jackson, and Saginaw, in the order named. The value of the clay products increased about 22 per cent, from $2,083,932 in 1911 to $2,545,498 in 1912.

The mining and calcining of gypsum is an industry of considerable importance in the State. There are three principal producing areas, designated by the Michigan Geological and Biological Survey as the Grand Rapids-Grandville, in Kent County; the Alabaster, in Iosco County; and the St. Ignace, in Mackinac County. The production of gypsum increased from 347,296 short tons, valued at $573,926, in 1911 to 384,297 short tons, valued at $621,547, in 1912.

The sand and gravel pits, which are distributed widely over the State, produced in 1911 2,185,165 short tons, valued at $565,969, and in 1912 2,681,821 short tons, valued at $818,603.

The principal quarry product is limestone, the value of which in 1912 was $1,139,560 out of a total value of stone produced of $1,192,204. In 1911 the total value of the stone produced in Michigan was $1,065,520, of which limestone contributed $1,001,535.

The other commercial mineral products are occasional gems, lime, manganiferous ore, mineral paints, mineral waters, natural gas, petroleum, quartz, scythestones, and silver (a by-product of copper mining). The total value of the mineral products in Michigan in 1912 was $80,062,486, against $65,275,324 in 1911, distributed by substances as shown in the following table:

Mineral production of Michigan in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel short tons	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Bromine...pounds	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Calcium chloride short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Cement.....do	.....	.....	3,686,716	$3,024,676	.....	.....	3,651,094	$3,145,001
Clay products.do	1,764	b $5,272	.....	2,083,932	2,043	b $6,173	.....	2,545,498
Coal.....do	1,476,074	2,791,461	.....	.....	1,206,230	2,399,451	.....	.....
Coke.....do	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Copper.....pounds	.....	.....	219,840,201	27,480,013	.....	.....	218,138,408	35,992,837
Gems and precious stones	.....	.....	.....	4,292	.....	.....	.....	1,432
Graphite, amorphous.short tons	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Grindstones	.....	.....	.....	153,292	.....	.....	.....	(a)
Gypsum..shorttons	347,296	.....	.....	573,926	384,297	.....	.....	621,547
Iron ore..long tons	8,945,103	23,810,710	.....	.....	12,797,468	29,003,163	.....	.....
Iron, pig.....do	.....	.....	304,654	b4,672,799	.....	.....	459,975	b6,579,048
Lime....short tons	.....	.....	80,709	352,608	.....	.....	74,720	311,448
Manganiferous ore long tons	c 358,468	(c)	.....	.....	c 532,393	(c)	.....	.....
Mineral paints, natural pigments short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters gallons sold	1,713,401	72,253	.....	.....	1,420,465	75,611	.....	.....
Natural gas	.....	1,330	.....	.....	.....	1,470	.....	.....
Petroleum..barrels	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Quartz..short tons	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Salt.....barrels	553,664	177,172	9,766,410	2,455,983	(a)	(a)	10,271,715	2,743,389
Sand and gravel short tons	2,185,165	565,969	.....	.....	2,681,821	818,603	.....	.....
Sand-lime brick	.....	.....	.....	210,001	.....	.....	.....	316,732
Scythestones	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver...fine ounces (troy)	.....	.....	497,281	263,559	.....	.....	528,453	324,999
Stone	.....	(d)	.....	d1,065,520	.....	(d)	.....	d1,192,204
Miscellaneous	.....	34,420	.....	1,524,754	.....	265,929	.....	1,896,490
Total value, eliminating duplications	$65,275,324				$80,062,486			

a Value included under "Miscellaneous."
b Value not included in total value.
c Tonnage and value included in iron ore.
d Stone sold rough included in derived product.

MINNESOTA.

Because of its great wealth in iron ores and on account of their extensive development Minnesota ranks ninth among all the States in the value of its mineral production. The mining of iron ore is the only important branch of the mining industry of the State, there being but two others—the clay-working and the quarrying industries—the value of whose production annually exceeds $1,000,000, whereas the value of the iron ore produced in Minnesota in 1912 was

nearly $62,000,000. In its output of iron ore Minnesota far outranks all other States and during the last three years has contributed both in quantity and value considerably more than half of the iron ore produced and marketed in the United States. In 1912 the total marketed production of iron ore in the United States was 57,017,614 long tons, valued at $107,050,153, of which Minnesota contributed 34,249,813 long tons, valued at $61,805,017. Minnesota's proportion of the marketed production was 60.07 per cent of the quantity and 57.74 per cent of its value. During 1911 exceptional conditions affected the iron industry, there being a marked depression in iron mining and in the manufacture of iron and steel, which depression was not experienced in any other branch of mining and manufacture. The production of iron ore in Minnesota accordingly decreased from 31,966,769 long tons in 1910 to 24,645,105 tons in 1911. The recovery in 1912 placed the production of Minnesota iron ore above the quantity mined in 1910, but the value of the ore in 1912 was nearly $16,500,000 less than in 1910. It is to be observed that the production of iron ore in Minnesota increased over 1910, while in Michigan it decreased. The combined production of the two States in 1910 was 45,270,675 long tons and in 1912 it was 45,623,198 tons, the difference of 352,523 tons being in favor of 1912. By far the largest part of the iron-ore production in the State is from the Mesabi iron range, now the most important iron-producing district of the world. The Mesabi is the youngest of the great iron ranges, the Cuyuna range, which has been developed in the last two or three years, not having attained notable prominence at the close of 1912, in which year its production amounted to 369,739 long tons. The Mesabi range was opened in 1892 with a production in that year of less than 30,000 tons. In 1894 it reached nearly 2,000,000 tons and in 1902, when 10 years of age, it produced over 13,000,000 tons or nearly one-half of the total output of Lake Superior iron ore. The Mesabi range reached its highest producing point in 1912 with an output of 32,604,756 long tons. Its previous record was in 1910 when 30,576,409 tons were produced. The Mesabi range lies entirely within Minnesota. The Vermilion range, one of the older producing districts, is also entirely within Minnesota, but its production in 1912 (1,457,273 tons) was not quite 5 per cent of the output of the Mesabi range in 1912. Its maximum production was attained in 1902—a total of 2,057,532 tons. The iron ore production of Minnesota is primarily the output of St. Louis County, whose production approximates 75 per cent of the total output. Itasca County continues to produce about 25 per cent of the total output and smaller quantities come from Crow Wing and Lake counties.

Exclusive of the iron ore the value of the mineral products of Minnesota in 1912 was $4,867,712, against $4,948,121 in 1911. Of these less important industries the principal products are from the quarries and clay pits, products of almost equal value. In 1911 the clay products, exclusive of pottery, were worth $1,693,478 and the stone production was worth $1,702,525. The corresponding value for clay products showed a decrease to $1,611,040 in 1912 and the stone increased to $1,845,746. The principal quarry products are granite, limestone, and sandstone and the leading counties in production are for granite Benton, St. Louis, Sherburne, and Stearns; for limestone Blue Earth, Hennepin, Lesueur, and Winona; and for sandstone Nicollet, Pine,

and Pipestone. The principal clay product is common brick, with smaller quantities of sewer pipe, fireproofing, front brick, drain tile, pottery, etc. Carver County is the principal producer of common brick. In the total value of its clay products Goodhue County leads, with Hennepin County second. The pottery industry is centered around Red Wing in Goodhue County. The other commercial products of the State are cement, feldspar, occasional gems, lime, mineral waters, sand and gravel, and sand-lime brick.

The total value of the mineral products in Minnesota in 1912 was $66,672,729, against $53,395,881 in 1911, distributed by substances as shown in the following table:

Mineral production of Minnesota in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	.....	.....	.....	[b]$1,693,478	(a) (c)	(a) (c)	.....	[b]$1,611,040
Coke.....short tons..	.....	.....	(a) (c)	(a) (c)	.....	.....	(a) (c)	(a) (c)
Feldspar .....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	.....	.....	.....	.....	400
Iron ore....long tons..	23,398,406	$48,447,760	.....	.....	34,249,813	$61,805,017	.....	.....
Iron, pig.....do....	.....	.....	56,668	[c]790,827	.....	.....	(a) (c)	(a) (c)
Lime.....short tons..	.....	.....	39,208	242,945	.....	.....	44,063	269,841
Mineral waters, gallons sold.....	8,703,319	270,039	.....	.....	8,881,018	252,277	.....	.....
Sand and gravel, short tons.....	1,522,295	399,980	.....	.....	946,339	278,578	.....	.....
Sand-lime brick.....	.....	.....	.....	93,734	.....	.....	.....	112,785
Stone.....	.....	(d)	.....	[d]1,702,525	.....	(d)	.....	[d]1,845,746
Miscellaneous.....	.....	(d)	.....	[d]908,324	.....	33,720	.....	1,732,555
Total value, eliminating duplications.....	$53,395,881				$66,672,729			

[a] Value included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value.
[d] Raw product included in derived product.

MISSISSIPPI.

The utilization of some of its clay resources and the digging of sand and gravel, particularly for building purposes, with the sale of some commercial mineral waters, constitute Mississippi's only title to consideration as a mining State. A small quantity of iron ore has been produced and some sand-lime brick is made in the State, but both of these are unimportant. The total value of the mineral products does not equal $1,250,000, the output being valued at $1,242,528 in 1912, and at $1,052,842 in 1911. The clay products, 87 per cent of which is common brick, were valued at $601,799 in 1912, against $687,836 in 1911, a decrease of about $86,000. The production of sand and gravel on the other hand increased from 631,084 short tons, valued at $286,206, in 1911, to 2,124,288 short tons, valued at $512,688, in 1912. The output of commercial mineral waters increased from 346,500 gallons sold, valued at $75,050, in 1911, to 639,905 gallons, valued at

$126,241, in 1912. The statistics of production during 1911 and 1912 have been as follows:

Mineral production of Mississippi in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				$687,836				$601,799
Iron ore.....long tons	(a)	(a)						
Mineral waters.....gallons sold	346,500	$75,050			639,905	$126,241		
Sand and gravel.....short tons	631,084	286,206			2,124,288	512,688		
Sand-lime brick				(a)				(a)
Miscellaneous		(b)		b 3,750				1,800
Total value, eliminating duplications	$1,052,842				$1,242,528			

a Value included under "Miscellaneous." b Raw product included in derived product.

MISSOURI.

Missouri leads all of the other States in the production of two important metals, zinc and lead, and in the production of two relatively unimportant nonmetals, barytes and tripoli, and ranks second in the production of mineral paints. The principal products of the State are spelter (zinc) and lead, the combined value of these two metals representing about 60 per cent of the total mineral output of the State, value considered. The quantity of sphalerite concentrate increased from 217,812 short tons, valued at $8,680,559, in 1911, to 244,986 tons, valued at $12,346,922, in 1912, and the quantity of zinc carbonate and silicate concentrate increased from 20,119 tons, valued at $477,420, in 1911 to 22,172 tons, valued at $641,881, in 1912. The recoverable zinc content of the ores produced in Missouri in 1912 amounted to 136,551 short tons of metal, valued at $18,884,038, against 122,515 short tons, in 1911, valued at $13,966,710. In 1911 the value of the lead produced exceeded that of spelter, but in 1912 the production of lead decreased, while, as shown above, the spelter showed a marked gain. The output of lead concentrates decreased from 258,240 tons, valued at $12,469,260, in 1911, to 256,838 tons, valued at $11,948,358, in 1912. The recoverable lead content of Missouri ores decreased from 178,868 short tons, valued at $16,098,120, in 1911, to 177,069 tons, valued at $15,936,210, in 1912. Missouri furnishes from 40 to 45 per cent of both the spelter and the lead produced in the United States. The lead ores of Missouri and of the other States of the Mississippi Valley carry so little silver that it is disregarded in the assay and sale of concentrate, and the lead produced from them is known to the trade as "soft lead." The principal lead-producing counties are St. Francois and Madison, in the eastern part of the State. In the Joplin region, which includes Jasper County, in southwestern Missouri, Cherokee County, in southeastern Kansas, and Ottawa County, in northeastern Oklahoma, lead is largely recovered as a by-product in zinc mining. Nearly all of the production of sphalerite ores is in the Joplin district, but about one-twentieth of the zinc silicate and carbonate ore was derived from mines in central and southeastern Missouri. The production in the

Joplin district in Missouri was smaller than usual in 1911, owing to the fact that a number of mines had shut down because of the low prices for zinc ores, and the production fell off more than 12 per cent, compared with 1910. The zinc content of the ore produced in Missouri in 1912 was about 7,000 tons more than the production of 1910, and 14,000 tons more than that of 1911, and the value in 1912 showed an increase of nearly $4,900,000 over each of the two preceding years.

Third in importance among Missouri's mineral industries is the mining of coal, the production of which increased from 3,836,107 short tons, valued at $6,603,066, in 1911 to 4,339,856 short tons, valued at $7,633,864, in 1912. Missouri ranks first in priority of coal production in the States west of Mississippi River, the census of 1840 showing a production of 9,972 short tons in that year, but the coal-mining industry has not shown the progress in Missouri that it has in some of the other States of the Middle West. Competition with the more cheaply mined coal of Illinois, and in the last few years (with the exception of 1912) with petroleum and natural gas in the mid-continent field of Oklahoma and Kansas, has retarded the development of Missouri's resources in coal. The coal-mining industry in the State during the last 10 years has been almost stationary, the output in 1912 being the maximum ever obtained, while the average for the last 10 years was 3,837,846 tons. The previous maximum production was in 1903, the first year of the decade. The coal-producing area lies entirely north and west of a line drawn from the northeastern to the southwestern corner of the State, and the principal coal-producing counties are Macon, Lafayette, Adair, Randolph, and Barton, in the order named.

Clay products are fourth in value of Missouri's mining industries. While ranking seventh among the States in the total value of its clay products, it ranks second in the manufacture of fire brick, which is the principal clay product of the State. The principal center of the industry is the immediate vicinity of St. Louis. The refractory brick made in Missouri are of especially high grade, and the average price of its fire brick is higher than that of any other State, with the exception of New Jersey, in which the manufacture of fire brick is an important industry. In the five leading States in the manufacture of fire brick the average prices in 1912 for that product were as follows: Pennsylvania, $18.44; Ohio, $17.16; New Jersey, $24.04; Kentucky, $18.81; Missouri, $19.86. The total value of Missouri's clay products in 1912 was $6,412,861, against $6,274,353 in 1911. Of the total value in 1912, $1,941,347 was from the manufacture of fire brick, $1,243,070 from the manufacture of common brick, $1,178,482 from sewer pipe, and $654,163 from architectural terra cotta. Vitrified brick, front brick, drain tile, and fireproofing are also important clay products in the State. In fact, Missouri contributes something to each branch of the brick and tile industry, as classified by the Survey.

The production of Portland cement, which is fifth in importance among Missouri's mining industries, increased from 4,114,859 barrels, valued at $3,349,312, in 1911 to 4,614,547 barrels, valued at $3,700,776, in 1912. The cement plants are located near St. Louis and Kansas City and also at Hannibal and Cape Girardeau all but the one near Kansas City being along Mississippi River, in the eastern part of the State.

The quarry products, principally limestone, were valued at about $2,500,000, the total value of the stone produced in Missouri in 1912 being $2,486,505, against $2,338,585 in 1911. Of these totals limestone contributed $2,373,725 in 1912 and $2,179,767 in 1911. The principal producing counties in limestone are Jackson, St. Louis City, Jasper, St. Louis, and Clay, in the order named. The principal counties in the production of granite are Iron and St. Francois.

The sand and gravel beds yielded 3,605,913 short tons, valued at $1,042,674, in 1911 and 3,687,380 short tons, valued at $1,088,279, in 1912. Most of the sand and gravel produced is mixed with cement in the manufacture of concrete. In 1912 the sand used for building purposes was valued at $522,664, and the gravel used (largely for concrete) was valued at $256,986, the two constituting 72 per cent of the total value of the sand and gravel produced.

The production of lime decreased slightly in 1912, amounting to 148,885 short tons, valued at $721,896, against 158,368 tons, valued at $722,563, in 1911.

The other mineral products of Missouri are copper, gems (occasional), iron ore, mineral waters, natural gas, pyrite, and silver. The total value of the mineral products of Missouri was $51,932,906 in 1911 and $58,332,550 in 1912, distributed by substances as shown in the following table:

Mineral production of Missouri in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	21,500	$81,380	.....	.....	24,530	$117,035	.....	.....
Briquets, fuel.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Cement.....barrels..	.....	.....	4,114,859	$3,349,312	.....	.....	4,614,547	$3,700,776
Clay products, short tons.....	227,691	b512,088	.....	6,274,353	295,701	b562,306	.....	6,412,861
Coal.....short tons..	3,836,107	6,603,066	.....	.....	4,339,856	7,633,864	.....	.....
Copper.....pounds..	.....	.....	640,411	80,051	.....	.....	440,725	72,719
Gems and precious stones	.....	.....	.....	25	.....	.....	.....	.....
Iron ore.....long tons..	72,810	153,776	.....	.....	42,120	92,996	.....	.....
Iron, pig.....do....	.....	.....	66,665	b1,108,940	.....	.....	(a) (b)	(a) (b)
Lead.....short tons..	.....	.....	178,868	16,098,120	.....	.....	177,069	15,936,210
Lime.....do....	.....	.....	158,368	722,563	.....	.....	148,885	721,896
Mineral paints:								
Natural pigments, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Zinc-lead pigments, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold.....	542,892	86,747	.....	.....	608,385	81,114	.....	.....
Natural gas.....	.....	10,496	.....	.....	.....	11,576	.....	.....
Petroleum.....barrels..	(a)	(a)	.....	.....	.....	.....	.....	.....
Pyrite.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Sand and gravel, short tons.....	3,605,913	1,042,674	.....	.....	3,687,380	1,088,279	.....	.....
Silver, fine ounces (troy).	.....	.....	49,867	26,429	.....	.....	35,438	21,794
Stone.....	.....	(c)	.....	c2,338,585	.....	(c)	.....	c2,486,505
Tripoli.....	.....	.....	.....	(a)	.....	.....	.....	75,569
Zinc.....short tons..	.....	.....	122,515	13,966,710	.....	.....	136,551	18,884,038
Miscellaneous.....	.....	9,795	.....	1,142,389	.....	(c)	.....	c1,369,933
Total value, eliminating duplications.....	$51,932,906				$58,332,550			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

MONTANA.

Montana ranks seventh among the States in the total value of its mineral products, (the chief industries being the mining and the smelting of copper ores), and second in the production of copper, Arizona ranking first. The production in both States increased notably in 1912—Montana from 272,847,705 pounds (recoverable metallic content of ore mined in the State), valued at $34,105,963, in 1911, to 309,738,873 pounds, valued at $51,106,914, in 1912, and Arizona from 306,141,538 pounds, valued at $38,267,692, in 1911, to 365,038,649 pounds, valued at $60,231,377, in 1912. The total value of Montana's mineral production was $53,498,194 in 1911 and $71,620,873 in 1912, indicating that the copper output approximates 70 per cent of the total. The center of the copper mining industry in Montana is, as is well known, in and around the city of Butte, Silver Bow County, with less important camps scattered through the southwestern part of the State. The reduction works are at Butte, Anaconda, and Great Falls. A small quantity of copper was produced in Montana as early as 1868, but it was not until 1882 (the first year for which the report, Mineral Resources of the United States, was published) that the industry began to assume importance. In 1881 the production of copper in Montana was less than 1,500,000 pounds, in the next year, 1882, it exceeded 9,000,000 pounds, and in the next five years, or by 1887, the production had increased nearly nine times and amounted to nearly 79,000,000 pounds. In 1887 Montana took first place among the States in the production of copper, outranking Michigan, and for 20 years (with the exception of 1891) continued to hold the supremacy until displaced by Arizona in 1907, since which time in one year only—1909—has Montana ranked first. Montana's production of copper to the close of 1912 has amounted to 5,907,024,710 pounds, slightly more than one-third of the total production of the United States since 1845.

In the production of silver Montana ranks third, being exceeded in this regard by Nevada and Utah. The silver product of Montana is second in importance among its mineral products. In 1912 the production of silver from Montana ores was 12,731,638 fine ounces, valued at $7,829,957, an increase from 11,985,196 fine ounces, valued at $6,352,154, in 1911. The value of the Nevada and Utah production of silver in 1912 exceeded that of Montana by about $1,000,000 and $700,000, respectively. Most of the silver produced in Montana is obtained as a by-product in the mining of copper. In 1912 10,735,743 fine ounces out of a total silver production of 12,731,638 ounces were from copper and copper-lead ores, and of this Silver Bow County contributed over 98 per cent. About 10 per cent of the total production of silver is from dry or siliceous ores with relatively small quantities from zinc ore, lead ore, and from placers. The second county in Montana in the production of silver is Jefferson, with Granite third.

The gold production of Montana decreased slightly, from 179,499 fine ounces, valued at $3,710,571, in 1911, to 175,371 fine ounces, valued at $3,625,235, in 1912. The largest production of gold in Montana is from Madison County, being principally recovered from placers by dredges. Placer mining is not carried on to any great extent in any other county, although some dredging is conducted in Lewis and Clark, Powell, Missoula, and other counties. Nearly 20

per cent of the total gold production is obtained from copper ores. The chief counties in the production of dry or siliceous ores from deep mines are Fergus, Blaine, Broadwater, Lewis and Clark, Madison, and Jefferson, in the order named. Zinc production decreased from 21,905 short tons, valued at $2,497,178, in 1911 to 13,459 short tons, valued at $1,857,403, in 1912. All of the production of zinc is from Silver Bow, Jefferson, Lincoln, and Fergus counties.

The total value of the metallic contents of the ores mined in Montana in 1912 was $64,754,613, or 90 per cent of the total mineral production of the State. The only branch of the nonmetallic industries which has been developed to any extent is coal mining, the principal operations being in Carbon, Musselshell, and Cascade counties. The maximum production in the State was made in 1912, 3,048,495 short tons, valued at $5,558,195, against 2,976,358 short tons, valued at $5,342,168, in 1911.

Montana leads in the production of precious stones, this supremacy being due to the mining of sapphire, one of the few instances of gem mining carried on as an industry in the United States. The total value of the gems produced in Montana in 1912 was $200,585, a decrease of about 10 per cent from the preceding year.

The other commercial mineral products of the State are cement, clay manufactures (principally common brick), grindstones, gypsum, iron ore, lead, lime, mineral waters, sand and gravel, sand-lime brick, and stone. The total mineral production of Montana in 1911 and 1912, distributed by substances, is shown in the following table:

Mineral production of Montana in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	4,912	[b] $9,617	.....	[c] $260,547	4,200	[b] $4,657	.....	[c] $314,017
Coal.....short tons..	2,976,358	5,342,168	.....	.....	3,048,495	5,558,195	.....	.....
Copper.....pounds..	.....	.....	272,847,705	34,105,963	.....	.....	309,738,873	51,106,914
Gems and precious stones.....	.....	.....	.....	221,613	.....	.....	.....	200,585
Gold, fine ounces (troy).....	.....	.....	179,499	3,710,571	.....	.....	175,371	3,625,235
Grindstones.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Gypsum..short tons..	(a)	.....	.....	(a)	(a)	.....	.....	(a)
Iron ore...long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Lead.....short tons..	.....	.....	3,216	289,421	.....	.....	3,723	335,104
Lime.....do....	.....	.....	3,100	18,480	.....	.....	(a)	(a)
Mineral waters, gallons sold.....	74,750	5,988	.....	.....	160,150	13,198	.....	.....
Sand and gravel, short tons.....	5,143	2,461	.....	.....	11,506	4,881	.....	.....
Sand-lime brick.....	.....	.....	.....	.....	.....	.....	.....	(a)
Silver, fine ounces (troy).....	.....	.....	11,985,196	6,352,154	.....	.....	12,731,638	7,829,957
Stone.....	.....	(d)	.....	[d] 212,233	.....	(d)	.....	[d] 216,079
Zinc.....short tons..	.....	.....	21,905	2,497,178	.....	.....	13,459	1,857,403
Miscellaneous.....	.....	(d)	.....	[d] 479,417	.....	(d)	.....	[d] 559,305
Total value, eliminating duplications.	$53,498,194				$71,620,873			

[a] Value included under "Miscellaneous."
[b] Value not included in total value.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Raw product included in derived product.

NEBRASKA.

Nebraska has been termed "the State without a mine," and possibly within the strict interpretation of what constitutes a mine this statement may be true. The State itself, however, contributed to the total mineral production in the utilization of its clay deposits, the digging of sand and gravel, the quarrying of stone, the sale of mineral waters, the manufacture of sand-lime brick, and in the production of volcanic ash or pumice. In the case of the last-mentioned article Nebraska ranks first among the States, with almost complete monopoly of the production. Less than 1 per cent of the total tonnage of pumice comes from States other than Nebraska. More than one-half of the total mineral production of the State is from the clay pits, which in 1912 furnished products valued at $805,398 out of a total of $1,490,582. In 1911 the clay products were valued at $795,894, out of a total of $1,316,168. The principal clay product is common brick, with smaller quantities of vitrified brick, front brick, drain tile, fireproofing, etc. The clay resources have their greatest development in Douglas, Lancaster, and Adams counties. Most of the limestone quarried in the State is crushed for use in the manufacture of concrete. The principal producing counties are Cass, Gage, and Sarpy. The total value of the stone produced in the State was $336,189 in 1912, against $263,501 in 1911. The output of sand and gravel was valued at $156,777 in 1911 and $257,597 in 1912. Although Nebraska ranks first in the production of pumice, the output may not be published separately as there are less than three producers in the State. A small quantity of sand-lime brick is manufactured in Dodge County. The quantity of mineral waters sold is negligible. The statistics of the mineral production of Nebraska in 1911 and 1912 are shown in the following table:

Mineral production of Nebraska in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products	.....	.....	.....	$795,894	.....	.....	.....	$805,398
Mineral waters..gallons sold..	21,641	$1,925	.....	.....	(a)	(a)	.....	.....
Pumice.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Sand and gravel.....do....	858,288	156,777	.....	.....	887,823	$257,597	.....	.....
Sand-lime brick	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone	.....	(b)	.....	b263,501	.....	(b)	.....	b336,189
Miscellaneous	.....	(b)	.....	b 98,071	.....	(b)	.....	b 91,398
Total value, eliminating duplications	$1,316,168				$1,490,582			

a Value included under "Miscellaneous." b Raw product included in derived product.

NEVADA.

Although Nevada is of much less relative importance as a mining State than it was in the days of the famous Comstock lode, it still

ranks first in the production of silver, though that metal was third among its mineral products in 1912. Nevada is fifth among the States in the production of copper (its most valuable product) and is fourth in the production of gold, which ranks second among the State's minerals. In 1911 Nevada ranked third in the output of gold, but with a decrease of over $4,500,000 it dropped to fourth place in 1912. The production of copper increased from 67,377,518 pounds, valued at $8,422,190. in 1911 to 86,477,494 pounds, valued at $14,268,787, in 1912. The output of gold decreased from 880,106 fine ounces, valued at $18,193,397, in 1911 to 650,943 fine ounces, valued at $13,456,180, in 1912. Gold was the only important metal whose output in Nevada decreased in 1912. The silver output increased from 13,184,601 fine ounces, valued at $6,987,839, in 1911 to 14,369,063 fine ounces, valued at $8,836,974, in 1912; the recoverable lead content of ores mined in the State increased nearly six times, from 1,632 short tons, valued at $146,865, in 1911 to 9,750 short tons, valued at $877,505 in 1912; and the recoverable zinc content of Nevada ores increased from 1,774 short tons, valued at $202,238, in 1911 to 6,661 short tons, valued at $919,286, in 1912. The total value of the metal production of Nevada, exclusive of iron ore, quicksilver, and tungsten (concentrates), was $33,952,529 in 1911 and $38,358,732 in 1912, the decrease in the production of gold being more than overcome by the increased production and advanced value of the other metals. More than 60 per cent of the gold production of Nevada in 1912 came from the Goldfield district in Esmeralda County, first productive in 1903, and the Tonopah district in Nye County, first productive in 1902. All but about 7 per cent of the gold produced in Nevada is from dry or siliceous ore. Of the total production of silver, the Tonopah district in Nye County contributes about 70 per cent, mainly from dry or siliceous ores, Churchill County ranks second, Storey County, the home of the Comstock, third, and Lincoln County fourth. The production of the Comstock was 618,006 fine ounces in 1911 and 806,853 ounces in 1912. The largest output from the Comstock was in 1876, when over 17,000,000 ounces of silver were produced. This famous district was opened in 1860 and ran a spectacular course for 20 years, and then somewhat rapidly declined. Copper mining on an important scale did not begin in Nevada until 1908, and the State now ranks fifth. White Pine County (Ely district) and Lyon County are the only producers of importance. In 1907, before the Ely district was thoroughly developed, the copper production of the State was less than 2,000,000 pounds. The recoverable copper content rose to nearly 15,600,000 pounds in 1908, to nearly 58,000,000 in 1909, to over 67,000,000 pounds in 1911, and to nearly 86,500,000 pounds in 1912. The total value of the mineral products of Nevada was $39,111,828 in 1912, against $34,501,832 in 1911. In addition to the five metals mentioned above the following mineral substances were produced. Clay products, coal (lignite), occasional gems, graphite (amorphous), gypsum, infusorial earth, iron ore, lime, mineral waters, quicksilver, salt, sand and gravel, stone, sulphur, and tungsten (concentrates). The total value of these products in 1912 amounted to $753,096, as compared with $38,358,732, for the combined produc-

tion of gold, silver, copper, lead, and zinc. The following table shows the quantity and value of the mineral products of Nevada in 1911 and 1912.

Mineral production of Nevada in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				(a)				(a)
Coal.....short tons	(a)	(a)			(a)	(a)		
Copper.....pounds			67,377,518	$8,422,190			86,477,494	$14,268,787
Gems and precious stones				6,295				15,356
Gold, fine ounces (troy)			880,106	18,193,397			650,943	13,456,180
Graphite, amorphous, short tons	(a)	(a)			(a)	(a)		
Gypsum....short tons	(a)			(a)	122,408			468,930
Infusorial earth				(a)				(a)
Iron ore.....long tons	(a)	(a)			(a)	(a)		
Lead.....short tons			1,632	146,865			9,750	877,505
Lime.....do			(a)	(a)				
Mineral waters, gallons sold	(a)	(a)			(a)	(a)		
Quicksilver.....flasks			(a)	(a)			(a)	(a)
Salt.....barrels	2,606	$2,405	10,250	14,547			12,536	15,752
Sand and gravel, short tons	223,510	33,591			(a)	(a)		
Silver, fine ounces (troy)			13,184,601	6,987,839			14,369,063	8,836,974
Stone				(a)		(b)		(a)
Sulphur.....long tons					(a)	(a)		
Tungsten ore (60 per cent concentrates), short tons			(a)	(a)			(a)	(a)
Zinc.....short tons			1,774	202,238			6,661	919,286
Miscellaneous		113,983		378,482		$118,502		134,556
Total value, eliminating duplications	$34,501,832				$39,111,828			

a Value included under "Miscellaneous." b Stone sold rough included in derived product.

NEW HAMPSHIRE.

The principal mineral product of New Hampshire is granite, the value of which ($1,017,272 in 1911 and $1,311,488 in 1912) represents more than one-half (two-thirds in 1912) of the total value of all the mineral production of the State. The principal quarrying operations are in Hillsboro, Merrimack, Cheshire, and Carroll counties, in the order named. The granite is used chiefly for building purposes and for monumental work.

The manufacture of common brick and of pottery are the only uses made of the clay resources of the State. The common-brick industry, which contributes about 25 per cent of the total value of the mineral products of the State, is located chiefly in Strafford and Rockingham counties.

The less important mineral products are fluorspar, garnet (abrasive), occasional gems, mica, mineral waters, and scythestones.

Mineral production of New Hampshire in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				[a] $430,748				[a] $492,096
Fluorspar....short tons	(b)	(b)			(b)	(b)		
Garnet.....do	(b)	(b)			(b)	(b)		
Gems and precious stones				20				650
Mica				44,927				37,338
Mineral waters, gallons sold	406,660	$139,130			240,568	$10,000		
Scythestones				(b)				(b)
Stone		(c)		[c] 1,017,272		(c)		[c] 1,311,488
Miscellaneous		24,708		70,840		20,235		78,069
Total value, eliminating duplications	$1,727,645				$1,949,876			

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Stone sold rough included in derived product.

NEW JERSEY.

New Jersey is the only State of any importance as a mineral producer in which the utilization of the clay resources constitutes the chief industry and represents over 50 per cent of the total output of the State. The clay products of New Jersey have included every variety of brick and tile, and every variety of pottery produced in the United States as classified by the Survey. The total value of the clay products in 1912 was $19,838,553, of which $10,902,633, or more than 50 per cent, was represented by the value of the brick and tile products, and $8,935,920 by the pottery. In 1911 the total clay products were valued at $18,178,228, of which $9,776,287 was the value of the brick and tile, and $8,401,941 was the value of the pottery. In the total value of the clay products New Jersey ranks third among the States, being exceeded by Ohio and Pennsylvania. It is second in the value of the pottery products, Ohio being first, and fourth in the value of brick and tile products. In 1912 it was first in the production of china and sanitary ware, and ranks among the first five in the production of most of the varieties of clay products. Mercer County, in which Trenton is located, is the most important clay-working county, and the city of Trenton is the center of the pottery industry. The leading product of Mercer County is sanitary ware. Middlesex County, second in importance, is the principal producer of common brick, architectural terra cotta, fireproofing, tile (not drain), and fire brick. Bergen County follows Middlesex in the manufacture of common brick.

In the discussion of the mineral products by States in 1911 New Jersey was credited only with the production of spelter made in the State. This method of presentation does not give to New Jersey the proper distinction as a producer of zinc. The production of spelter in New Jersey in 1911 was 15,128 short tons, increasing in 1912 to

16,941 short tons. If, however, the recoverable zinc content of the ore produced in New Jersey be considered, the production in 1911 amounted to 77,445 short tons, valued at $8,828,781, and in 1912 to 69,755 short tons, valued at $9,626,191. The latter method is pursued in the presentation of the statistics of New Jersey's mineral production in the present report. It advances the zinc-mining industry to second in importance in the State, and makes New Jersey second in rank as a producer of zinc, being exceeded only by Missouri. This change in method brings the total value of New Jersey's mineral production in 1911 up to $34,663,435 from $27,559,246. It is to be noted that there was a decrease of approximately 7,700 short tons in the quantity of zinc content of the ores mined in 1912 as compared with 1911, but an increase of approximately $800,000 in the value, due to the advances in the prices of spelter during 1912. The center of the zinc-mining industry in New Jersey is the famous Franklin Furnace district in Sussex County, the most northerly county of the State. Mining has been carried on continuously in this district for over 60 years.

Third among the industries in importance is the manufacture of Portland cement, the plants in the vicinity of Phillipsburg, Warren County, being the eastern end of the celebrated Lehigh district of Pennsylvania. The production increased slightly from 4,411,890 barrels in 1911 to 4,490,645 barrels in 1912, but the value declined from $3,259,528 to $3,052,098.

The principal quarry product of New Jersey is trap rock, produced in the Palisades region (principally Somerset, Passaic, Hunterdon, Essex, and Hudson counties) and used chiefly for road making and concrete. The total value of all stone quarried in New Jersey in 1911 was $1,597,410, of which $1,136,385 was the value of the trap rock produced. The total value of all stone produced in 1912 was $1,716,829, of which $1,202,397 was the value of the trap rock. Limestone was produced to the value of $138,148 in 1911 and $205,334 in 1912, and was quarried in 1912 chiefly in Sussex county. Sandstone is produced principally in Bergen and Mercer counties.

New Jersey is one of the leading producers of molding sand, the output in 1911 amounting to 715,654 short tons, valued at $392,840, and in 1912 to 459,397 short tons, valued at $279,948. The building sand produced in the State was 1,501,951 short tons, valued at $242,659 in 1911, and 1,425,861 short tons, valued at $316,435, in 1912. The total value of all sand and gravel produced increased from $1,058,926 to $1,146,640.

The only other mineral product of New Jersey which exceeded $1,000,000 in 1912 is iron ore, of which 359,721 long tons, valued at $1,158,271, were marketed in 1911, and 366,823 long tons, valued at $1,192,816, in 1912.

The other natural mineral products of the State are: Occasional gems, lime, mineral paints, mineral waters, sand-lime brick, slate, and talc. The total value of the mineral products of New Jersey, with their distribution by substances in 1911 and 1912, is shown in the following table:

Mineral production of New Jersey in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel..short tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Cement.....barrels..	.....	.....	4,411,890	$3,259,528	.....	.....	4,490,645	$3,052,098
Clay products..short tons..	405,912	b$658,875	.....	18,178,228	438,883	b$702,008	.....	19,838,553
Coke.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Gems and precious stones..	.....	.....	.....	350	.....	.....	.....	228
Iron ore.....long tons..	359,721	1,158,271	.....	.....	366,823	1,192,816	.....	.....
Iron, pig.....do....	.....	.....	41,835	b 583,300	.....	.....	(a) (b)	(a) (b)
Lime.....short tons..	.....	.....	27,057	113,784	.....	.....	16,538	65,241
Mineral paints:								
Natural pigments, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Zinc-lead pigments, short tons.....	.....	.....	(a)	(a)	.....	.....	.....	.....
Mineral waters, gallons sold.....	2,233,627	210,123	.....	.....	2,386,217	209,726	.....	.....
Sand and gravel, short tons.....	3,352,765	1,058,926	.....	.....	3,245,767	1,146,640	.....	.....
Sand-lime brick.....	.....	.....	.....	17,710	.....	.....	.....	6,924
Slate.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone.....	.....	(c)	.....	c1,597,410	.....	(c)	.....	c1,716,829
Talc.....short tons..	.....	.....	(a)	(a)	(c)	(c)	(a)	(a)
Zinc.....do....	.....	.....	77,445	8,828,781	.....	.....	69,755	9,626,191
Miscellaneous.....	.....	.....	.....	925,056	.....	.....	.....	1,302,425
Total value, eliminating duplications.	$34,663,435				$36,881,930			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

NEW MEXICO.

Until 1912 New Mexico was one of the two States included in the Rocky Mountain division, Wyoming being the other, which lay more claim to recognition as mining States by reason of their production of coal than by their output of precious and semiprecious metals. In 1912, however, owing to a marked increase in the production in copper, the value of the recoverable copper content of the ores mined in New Mexico exceeded the value of the coal produced. The increase in the copper production was due principally to the operations of one company mining with steam shovels a large acreage of low-grade deposits at Santa Rita. In 1911 the recoverable copper content of the ores mined in New Mexico was 4,057,040 pounds, valued at $507,130; in 1912 this product amounted to 34,030,964 pounds, valued at $5,615,109, the quantity of output in 1912 being approximately 8½ times that of 1911, while the value was more than 11 times. The coal production increased from 3,148,158 short tons, valued at $4,525,925, to 3,536,824 short tons, valued at $5,037,051. The principal coal mining operations are in the Raton district, Colfax County, and in the Gallup district, McKinley County. These two districts produce over 90 per cent of the coal output of the State. The Raton district produces a good grade of coking coal, and extensive coking operations are carried on at Dawson, Gardner, and Koehler. Except for the notable increase in the production of copper in New Mexico in 1912 the State has made little pretension to importance in the production of metals. The combined value of the gold, lead, silver, and zinc was approximately 50 per cent of the value of the copper produced in 1912. The

gold production, most of which is from siliceous ore mined at Mogollon in Socorro County, was valued at $784,446 in 1912, against $762,808 in 1911. The Mogollon district is also the chief producer of silver, of which the production amounted to 1,536,701 fine ounces, valued at $945,071, in 1912, against 1,354,540 fine ounces, valued at $717,906, in 1911. The recoverable zinc content of ores produced in New Mexico in 1912 was 6,783 short tons, valued at $936,098, against 5,119 short tons, valued at $583,519, in 1911. The zinc producing counties are Socorro, Grant, Luna, and Santa Fe, all of the product of Santa Fe County and part of that from Socorro County being from lead-zinc ores. The lead production is relatively unimportant, having amounted in 1912 to 2,747 short tons, valued at $247,231, against 1,483 short tons, valued at $133,480. The only quarry product of any importance is limestone from Valencia, Guadalupe, and Lincoln counties, which constitutes over 70 per cent of the entire stone production of the State. It is used chiefly for railroad ballast. The value of the stone produced decreased from $406,454 in 1911 to $335,937 in 1912. The clay-working industries have not been extensively developed, the total value of products made in 1912 being $185,575, against $174,651 in 1911. The other commercial mineral products of the State are: Fluorspar, gypsum, iron ore, lime, mica, mineral waters, salt, sand and gravel, occasional gems, and vanadium minerals. The total value of the mineral products of New Mexico increased from $8,176,229 in 1911 to $14,391,355 in 1912, the gain of 76 per cent (the record percentage for the year) being due principally to the increased production of copper. The distribution by subjects for the two years is shown in the following table:

Mineral production of New Mexico in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.short tons	8,514	[a] $12,800	.....	[b] $174,651	1,943	[a] $4,214	.....	$185,575
Coal.....do	3,148,158	4,525,925	.....	.....	3,536,824	5,037,051	.....	.....
Coke.....do	.....	.....	381,927	[a] 1,240,963	.....	.....	413,906	[a] 1,356,946
Copper.....pounds	.....	.....	4,057,040	507,130	.....	.....	34,030,964	5,615,109
Fluorspar.....short tons	(c)	(c)	.....	.....	(c)	(c)	.....	.....
Gems and precious stones	.....	.....	.....	26,655	.....	.....	.....	795
Gold...fine ounces (troy)	.....	.....	36,901	762,808	.....	.....	37,948	784,446
Gypsum.....short tons	(c)	.....	.....	(c)	(c)	.....	.....	(c)
Iron ore.....long tons	145,195	146,401	.....	.....	(c)	(c)	.....	.....
Lead.....short tons	.....	.....	1,483	133,480	.....	.....	2,747	247,231
Lime.....do	.....	.....	1,945	13,004	.....	.....	1,325	9,434
Mica	.....	.....	.....	(c)	.....	.....	.....	(c)
Mineral waters, gallons sold	226,333	41,833	.....	.....	(c)	(c)	.....	.....
Salt.....barrels	.....	.....	(c)	(c)	.....	.....	(c)	(c)
Sand and gravel, short tons	267,615	18,774	.....	.....	125,872	29,963	.....	.....
Silver.fine ounces (troy)	.....	.....	1,354,540	717,906	.....	.....	1,536,701	945,071
Stone	.....	(d)	.....	[d] 406,454	.....	(d)	.....	[d] 335,937
Vanadium....short tons	.....	.....	(c)	(c)	.....	.....	(c)	(c)
Zinc.....do	.....	.....	5,119	583,519	.....	.....	6,783	936,098
Miscellaneous	.....	(d)	.....	[d] 117,689	.....	179,428	.....	85,217
Total value, eliminating duplications.	$8,176,229				$14,391,355			

[a] Value not included in total value.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Raw product included in derived product.

NEW YORK.

New York, first in the number of its inhabitants and first in the value of its manufactures, ranks second in the number of mineral substances produced commercially and sixteenth in the value of its total mineral output. It produces no coal, but is favored with a significant output of natural gas and petroleum. It produces practically none of the precious and semiprecious metals. It is important as a producer of pig iron, the output from the blast furnaces of the State amounting to 1,537,201 long tons, valued at $23,924,194, in 1911 and to 1,973,090 long tons, valued at $28,059,058, in 1912; but pig iron is not included in the total value of the mineral production, and the quantity of iron ore marketed, which is included in the total, was only 1,057,984 long tons, valued at $2,959,009, in 1911 and 1,167,405 long tons, valued at $2,933,024, in 1912. With pig iron eliminated the clay products constituted the chief item in the State's mineral production. The chief clay product is common brick manufactured principally in the Hudson River region, embracing the counties of Albany, Columbia, Dutchess, Greene, Orange, Rensselaer, Rockland, Ulster, and Westchester, this being probably the largest brick-producing region in the world. New York contributes to each variety of clay product, as classified by the Survey, the most important of which, next to common brick, are porcelain electrical supplies and architectural terra cotta. The total value of the clay products, including pottery, was $12,058,858 in 1912, against $10,184,376 in 1911. The clay-working industries contribute approximately 30 per cent of the total value of the mineral products of the State. Although New York ranks relatively low among the States, particularly when the number of its mineral products is considered, it is the premier producer (value considered) of eight mineral substances, as follows: Emery, abrasive garnet, graphite, gypsum, millstones, commercial mineral waters, fibrous talc, and natural cement. It is second in the production of feldspar, salt, sand and gravel, iron pyrite, and sand-lime brick; third in the production of infusorial earth and stone; and fourth in iron ore and pig iron. All of the substances, however, in the production of which New York ranks relatively high are not of conspicuous importance in the mining industry.

Next to the clay products those of the quarries represent the largest value of New York's mineral production, and, as previously stated, New York ranks third in the value of quarry products, being exceeded only by Pennsylvania. The total value of the stone produced in the State in 1912 was $6,415,015 (a little more than 50 per cent of the value of the clay products), as compared with $6,895,466 in 1911. The principal stone quarried is limestone, produced principally in Erie, Ulster, Onondaga, Genesee, Rockland, Niagara, and Albany counties in the order named. Its principal use is for road making, railroad ballast, concrete, and flux, nearly 90 per cent of the total value of the limestone produced being for these purposes. Sandstone is produced principally in Orleans County and bluestone in Ulster, Delaware, and Wyoming counties, the principal uses being building, curbing, and flagging. Trap rock is produced chiefly in Rockland County and used principally for concrete and road making. Granite and marble are also produced, but are relatively unimportant.

The iron-ore production already referred to consists principally of magnetite, more than half of which comes from the vicinity of Port Henry, on Lake Champlain.

The cement production of New York amounted to 3,601,789 barrels, valued at $2,812,440 in 1911, of which 3,314,217 barrels, valued at $2,669,194, was Portland cement. In 1912 the marketed production (or shipments) of cement was 4,857,960 barrels, valued at $3,610,365, of which 4,543,060 barrels was Portland cement, valued at $3,448,735. The manufacture of natural cement, which at one time was an important industry in New York, has been almost entirely displaced by Portland cement, of which a more uniform product can be made than is possible in the manufacture of natural cement. The location of the former important natural-cement industry was in the vicinity of Rosendale, and by far the larger portions of the natural cement produced in the United States was from this district. In 1882 the total production of natural cement was 3,165,000 barrels. From 1891 to 1900 the average annual production was about 8,000,000 barrels. In 1904 the decline began and continued rapidly until 1911 and 1912, when the total production of natural cement in the United States was less than 1,000,000 barrels.

The gypsum products of the State in 1911 were valued at $1,199,596 and in 1912 at $1,241,514. This is one of the eight mineral industries in which New York ranks first. The quantity of gypsum mined was 472,834 short tons in 1911 and 506,996 short tons in 1912. The values as given above are for the production in the condition when first sold, whether the material was marketed crude, ground for land plaster, or calcined into plaster of Paris. When calcined the value of the calcined product is considered. The principal counties in the production of gypsum are Erie, Genesee, Monroe, and Onondaga.

New York ranks second in the production of salt, about half of which is obtained from evaporation of brine, principally in Schuyler, Tompkins, Wyoming, and Onondaga counties. The production in Onondaga County is obtained largely by solar evaporation from brines taken from the State reservation. The production in the other districts, of which Warsaw, in Wyoming County, is the most important, is obtained by artificial evaporation.

The production of fibrous talc is practically a monopoly enjoyed by New York. It is used in the manufacture of medium grades of paper and is produced almost exclusively at Gouverneur, in St. Lawrence County.

Fifth in importance among the mineral products of the State of New York is sand and gravel, the output of which amounted to 7,237,303 short tons, valued at $2,561,516 in 1912, against 7,537,578 short tons, valued at $2,414,452 in 1911. Building sand constitutes 45 per cent of the total value, and nearly 30 per cent more is in the value of the gravel, which is also largely used in structural work.

The value of the natural gas produced in the State increased from $1,418,767 in 1911 to $2,343,379 in 1912, and became in the latter year the sixth in importance among the State's mineral products.

The only other natural products whose values exceed $1,000,000 are petroleum, which was worth $1,401,880 in 1912, and mineral waters, sales of which were valued at $1,034,477.

Coke is made in by-product ovens at Lackawanna, Syracuse, and Geneva from coal mined in Pennsylvania. The production of coke

increased from 686,172 short tons, valued at $2,883,990, in 1911 to 794,618 short tons, valued at $3,203,133, in 1912. The value of the coke production, however, like that of pig iron, is not included in the total value.

The production of aluminum, obtained by electric smelting at Niagara Falls and Massena, is one of the industries in which New York leads, but the statistics of production in the State may not be published without divulging confidential information and are not included in the statement of total value.

In addition to the substances discussed above New York produces gems (occasionally), lead, lime, mica, metallic paints and other natural pigments, quartz, slate, and zinc. The total value of the mineral products was $38,406,473 in 1912, against $34,317,594 in 1911, distributed by substances as shown in the following table:

Mineral production of New York in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Abrasives, artificial, pounds			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Aluminum....pounds			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Briquets, fuel, short tons			22,350	b $123,925			(a) (b)	(a) (b)
Cement.....barrels			3,601,789	2,812,440			4,857,960	$3,610,365
Clay products, short tons	4,882	b $10,308		10,184,376	7,845	b $18,718		12,058,858
Coke.....short tons			686,172	b 2,883,990			794,618	b 3,203,133
Emery.....do	(a)	(a)			(a)	(a)		
Feldspar.....do	18,800	79,926			22,192	101,525		
Ferroalloys..long tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Garnet, abrasive, short tons	3,323	100,440			3,601	117,865		
Gems and precious stones								100
Graphite: Crystalline, pounds	2,480,000	136,750			2,648,000	146,415		
Artificial, pounds			10,144,000	b 664,000			12,896,347	b 830,193
Gypsum...short tons	472,834			1,199,596	506,996			1,241,514
Infusorial earth				(a)				(a)
Iron ore.....long tons	1,057,984	2,959,009			1,167,405	2,933,024		
Iron, pig.....do			1,537,201	b 23,924,194			1,973,090	b 28,059,058
Lead.....short tons			(a)	(a)				
Lime.....do			119,707	524,845			109,800	495,265
Mica								(a)
Millstones				13,335				34,246
Mineral paints, natural pigments, short tons			12,303	66,406			15,988	72,972
Mineral waters, gallons sold	10,245,261	939,003			10,008,801	1,034,477		
Natural gas		1,418,767				2,343,379		
Petroleum.....barrels	952,515	1,248,950			874,128	1,401,880		
Pyrite.....long tons	(a)	(a)			(a)	(a)		
Quartz.....short tons	(a)	(a)			(a)	(a)		
Salt.....barrels	(a)	(a)	6,395,336	1,373,664	(a)	(a)	6,600,914	1,743,587
Sand and gravel, short tons	7,537,578	2,414,452			7,237,303	2,561,516		
Sand-lime brick				95,930				128,700
Slate				120,359				135,207
Stone		(c)		c 6,895,466		(c)		c 6,415,015
Talc, fibrous, short tons			62,030	613,286			66,867	656,270
Zinc.....do			(a)	(a)			14	1,932
Miscellaneous		1,107,749		9,257,565		1,169,746		10,605,351
Total value, eliminating duplications		$34,317,594				$38,406,473		

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

NORTH CAROLINA.

North Carolina leads in the production of mica, and has been the principal producer of monazite in the United States, but no monazite has been mined on a commercial scale in North Carolina nor in the United States for the last two years. In the production of barytes North Carolina ranked third in both 1911 and 1912. The State is not of much importance as a mineral producer, the total value of its mineral production in 1912 being $3,368,923 against $2,793,825 in 1911. The principal industry, based upon the value of the products, is clay working, nearly one-half of the total value of the mineral production in 1912 being that of clay products, principally common brick and sewer pipe, with small quantities of front brick, drain tile, fire brick, and pottery. The value of the clay products of North Carolina in 1912 was $1,465,653, compared with $1,280,126 in 1911. The principal clay-working counties are Guilford, Wayne, and Wake. North Carolina leads in the production of kaolin, a high-grade white-burning clay used by the potters. It is mined in Jackson, Macon, Mitchell, and Swain counties. The total raw clay produced in the State in 1912 was valued at $139,821 against $130,610 in 1911. Second in importance among the mineral products of North Carolina is stone, the output of which continued to increase almost constantly during the last ten years, having amounted in value to $224,512 in 1903 and increased to $1,054,872 in 1912, an advance of 370 per cent. The principal stone quarried is granite, which is obtained chiefly in Buncombe, Mecklenburg, Rockingham, Rowan, Surry, Vance, and Warren counties, the larger quarries being in Surry and Rowan counties. Granite from the two last-mentioned counties is being shipped to many parts of the United States, and to that fact is due the large increased production of the last few years. Sandstone, marble, and limestone are also quarried, but in relatively small quantities. The larger part of the production of granite is for curbing and paving blocks; crushed stone for concrete, road making, and railroad ballast coming second; and that used for building purposes third.

North Carolina continues to be the largest producer of mica, the output of that mineral in 1912 being valued at $256,549, an increase of $39,250 over 1911. The white mica of the State is still known as the standard mica, equal in quality to any in the market. It is white muscovite, highly prized for its transparency, and especially adapted to the manufacture of gas-lamp chimneys and lamp shades and to the stove trade, the sheet mica used for these purposes bringing the highest price. Smaller sizes are used for electrical apparatus, and the scrap mica is ground and sold for use in the manufacture of lubricants, for wall paper, etc.

North Carolina does not rank high in the production of any of the metals, but has continued for some years to show an increase in the production of gold, and in 1912 the increase over 1911 was more than 100 per cent, the values being $166,014 in 1912 and $70,282 in 1911. Prior to the discovery of gold in California North Carolina was one of the leading gold-producing States of the country, and recent developments in the Piedmont section of the State seem to indicate that gold mining will again assume considerable importance. The reopening of the Silver Hill mine in Davidson County, which yields

an ore containing gold, silver, lead, and zinc, accounts for the production of lead and zinc in North Carolina during 1912. There was no production of either metal in 1911.

The iron-ore production of North Carolina is the magnetic iron ore of the Cranberry iron mine in Avery County. There is a constantly increasing demand for the pig iron made from this ore, as it is especially adapted to certain uses, in which exceptionally pure pig is required. The other mineral substances produced on a commercial scale in the State are copper, feldspar, abrasive garnet, gems, lime, millstones, mineral waters, quartz, sand and gravel, silver, talc, and soapstone. A small quantity of coal was produced for local consumption in 1911 and 1912, and a small quantity of amorphous graphite in 1911.

The following table shows the quantity and value of the mineral products of North Carolina in 1911 and 1912:

Mineral production of North Carolina in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)			(a)	(a)		
Clay products.....do....	14,903	b$130,610		$1,280,126	15,058	b$139,821		$1,465,653
Coal.....do....	(a)	(a)			(a)	(a)		
Copper.....pounds..							75,915	12,526
Feldspar.....short tons..	(a)	(a)			(a)	(a)		
Garnet, abrasive....do....	(a)	(a)			(a)	(a)		
Gems and precious stones..				10,735				5,655
Gold..fine ounces (troy)..			3,400	70,282			8,031	166,014
Graphite, amorphous, short tons.....	(a)	(a)						
Iron ore.....long tons..	84,782	148,369			(a)	(a)		
Lead.....short tons..							46	4,140
Lime.....do....			7,809	33,543			6,693	30,559
Mica.....				217,299				256,549
Millstones.....				(a)				9,352
Mineral waters, gallons sold.....	231,510	31,108			144,708	22,385		
Monazite and zircon, pounds.....	(a)	(a)						
Quartz.....short tons..					(a)	(a)		
Sand and gravel....do....	251,977	93,336			161,198	38,487		
Silver..fine ounces (troy)..			943	500			4,854	2,985
Stone.....		(c)		c 826,928		(c)		c1,054,872
Talc and soapstone, short tons.....	(c)	(c)	(a)	(a)	(c)	(c)	c 3,542	c 63,304
Zinc.....short tons..							142	19,549
Miscellaneous.....		17,725		63,874		216,893		
Total value, eliminating duplications	$2,793,825				$3,368,923			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

NORTH DAKOTA.

North Dakota belongs to the Great Plains region and does not lay claim to any importance as a mineral producer. The total mineral output in 1912 was valued at only a little more than $1,000,000, three-fourths of which was the value of the lignite produced, and the most of the remainder was the value of the clay products of the State.

The lignite of North Dakota has been found to make an excellent fuel for burning brick(as it is relatively free from smoke and maintains a uniform temperature in the kilns. The University of North Dakota has been conducting some interesting experiments on the utilization of the lignite resources of the State for gas making and for the manufacture of briquets. The area underlain by lignite in North Dakota is larger than the total coal area of any other State except Illinois and Montana, and as the gas producer and the internal-combustion engine in large units come into more general use in the West and the briquetting industry (for furnishing domestic fuel) becomes more highly developed, the lignite resources of North Dakota will be found to possess great potentialities in the settlement and economic development of the State. The quantity of lignite produced in 1912 was a little less than in 1911, but that was probably due to the milder winter of 1912. The value of the product, in sympathy with the general advance in coal values throughout the United States, increased in 1912. The production of 1911 was 502,628 short tons, valued at $720,489, and in 1912, 499,480 tons were produced, valued at $765,105. The value of the clay products increased about 10 per cent, from $210,616 in 1911 to $231,245 in 1912. The total value of the mineral products was $1,025,741 in 1912, against $957,425 in 1911. There are no metal-mining operations in the State, and aside from the lignite and the clay production, the only mineral substances produced in North Dakota are natural gas, sand, and gravel, sand-lime brick, and some commercial mineral waters.

The following table shows the quantity and value of the mineral products of North Dakota in 1911 and 1912:

Mineral production of North Dakota in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products....short tons..	(a) (b)	(a) (b)	.....	$210,616	(a) (b)	(a) (b)	.....	$231,245
Coal.....do....	502,628	$720,489	.....	.....	499,480	$765,105	.....	.....
Mineral waters..gallons sold..	(a)	(a)	.....	.....	.....	.....	.....	.....
Natural gas.....	.....	(a)	.....	.....	.....	(a)	.....	.....
Sand and gravel..short tons..	23,160	15,795	.....	.....	31,803	16,514	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Miscellaneous.....	.....	c 11,345	.....	(c)	.....	c 13,831	.....	(c)
Total value, eliminating duplications.....	$957,425				$1,025,741			

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product included in raw product.

OHIO.

Ohio is the premier State in the manufacture of clay products and of grindstones and pulp stones. It is second in the production of pig iron (but of no importance as a producer of iron ore), bromine, and lime. It is third in the value of its output of calcium chloride, natural gas, salt, sand and gravel, and gypsum, and fourth in the

production of coal, oilstones and scythestones, and stone. The pig-iron production, which amounted to 7,127,176 long tons, valued at $93,140,369, in 1912, and 5,371,378 long tons, valued at $73,484,592, in 1911, is not included in the total mineral production. If the value of the pig iron made in Ohio were included, the State would rank second as a mineral producer, being exceeded only by Pennsylvania. Pig iron excluded, Ohio falls to fourth place in rank, the larger production of coal in Illinois and West Virginia giving those States precedence over Ohio. Of the mineral products of Ohio, coal and clay are rivals for first place in the value of production. In 1909 the value of the clay products exceeded that of coal; in 1910 the value of the coal exceeded that of clay; they alternated in 1911 and again in 1912. The production of coal in 1912 amounted to 34,528,727 short tons, valued at $37,083,363, while the value of the clay products was $34,811,508. In 1911 the coal production was 30,759,986 short tons, valued at $31,810,123, and the value of the clay products was $32,663,895. All of the coal production of Ohio is of the bituminous variety, although some of it, like the block coal of Indiana, is usable raw as a blast-furnace fuel. When so used it is generally mixed with coke. The principal coal-producing counties are, in the order of their importance, Belmont, Jefferson, Athens, Guernsey, Perry, Hocking, and Tuscarawas; but all of the counties east of a line drawn from Cleveland, on Lake Erie, on the north to Portsmouth on the south, with the exception of Ashtabula, Geauga, Lake, and Washington counties, are producers of coal. Each of the seven counties mentioned produced more than 1,000,000 tons of coal in 1912; three of them had each an output of over 4,000,000 tons; and one—Belmont—attained an output of nearly 9,400,000 tons. In 1882, at the beginning of this series of reports, Ohio's total production of coal was 9,450,000 tons, only a little more than the output of Belmont County in 1912. The production of a little over 34,500,000 tons in the State in 1912 was the maximum production obtained.

The principal clay-working counties are Columbiana, Muskingum, Summit, Jefferson, Mahoning, Perry, Stark, Cuyahoga, Tuscarawas, and Carroll, in the order named. Brick and tile represent about 55 per cent of the total value of the clay products, and pottery about 45 per cent. In 1911 the total value of the clay products of Ohio was $32,663,895, of which brick and tile constituted $17,888,630, and the pottery products $14,775,265. In 1912 the total value of the clay products was $34,811,508, of which $19,302,773 represented the output of brick and tile works and $15,508,735 that of the pottery works. Sewer pipe represents the largest value in the products of the brick and tile industry, with vitrified brick second, tile other than drain third, and common brick fourth. The pottery industry of Ohio is made up largely of the manufacture of high-grade pottery wares, most of the plants being along Ohio River, chiefly at East Liverpool and vicinity. Over 60 per cent of the total production of pottery in Ohio is white ware. Stoneware, and yellow and Rockingham ware, and porcelain electrical supplies constitute important products. Ohio is slightly exceeded by Pennsylvania in the value of its brick and tile products, but the difference in favor of Pennsylvania in 1912 was about $106,000—less than 1 per cent—while in the value of pottery Ohio led New Jersey, the second in rank, by over

$6,500,000, or more than 70 per cent. The production of petroleum, which ranks third among the State's mineral industries, increased from 8,817,112 barrels in 1911 to 8,969,007 barrels (including a small amount from Michigan) in 1912. The value showed a considerably greater gain in proportion, from $9,479,542 to $12,085,998. The principal petroleum-producing counties are Allen, Hancock, Lucas, Sandusky, Seneca, Van Wert, and Wood, in the northwestern part of the State, and Belmont, Carroll, Fairfield, Harrison, Hocking, Jefferson, Licking, Monroe, Morgan, Noble, Perry, and Washington, in the eastern and southern parts. The production of petroleum has been declining in the northwestern corner of the State, which constitutes a part of the well-known Lima-Indiana field, where the oil of Lima grade is produced. Drilling in the central part of the State between the older producing districts was quite active in 1912, and good results were obtained.

Natural gas follows only a little behind petroleum in the value of its output in Ohio, the production in 1911 being valued at $9,367,347, and in 1912 at $11,891,299. The chief counties in the production of natural gas are Licking, Knox, Ashland, and Fairfield. Fifth in importance among Ohio's mining industries is the quarrying of stone. The principal quarry product is limestone, of which there is a large quantity and great variety in the State. The use of this limestone is chiefly for road making, railroad ballast, the manufacture of concrete, iron flux, and lime burning. The principal producing counties are Ottawa, Franklin, Erie, Lucas, Seneca, and Wood, in the order named. The production of sandstone is about 27 per cent that of limestone. This is largely from the Berea sandstone, or grit, which also produces the grindstones and pulp stones in the production of which Ohio leads. Sandstone is produced in many counties in the eastern half of the State, but the great quarries from which building stone is obtained are in Lorain and Scioto counties. Cuyahoga County is an important producer of sandstone, but the product is used chiefly for curbing and flagging. The total value of the stone produced in Ohio in 1912 was $6,197,388, to which the limestone quarries contributed $4,885,088 and the standstone quarries $1,312,300. In 1911 the total value of the quarry products was $5,796,829. The other mineral products of the State, whose total value exceeded $1,000,000 in 1912, are sand and gravel, lime, salt, and cement. To these coke might be added, made mostly in by-product ovens and from coal drawn from West Virginia's mines. The sand and gravel production of Ohio was 5,874,412 short tons, valued at $2,304,968, in 1912, against 5,281,637 short tons, valued at $2,104,776, in 1911. All kinds of sand have been produced in the State, the largest value in 1912 being expressed by molding sand, in the production of which Ohio ranks first among the States, with its output valued at $649,896. The value of the building sand was $629,174, these two constituting more than 55 per cent of the total value of the sand and gravel produced in the State. The gravel, used principally for railroad ballast, constitutes nearly 25 per cent of the total sand and gravel product. The lime production increased from 405,562 short tons, valued at $1,607,524, in 1911, to 464,479 short tons, valued at $1,929,584, in 1912. The salt production, in which Ohio ranks third among the States, was 5,269,179 barrels, valued at $1,364,136, in 1912, against 4,302,507 barrels, valued at $1,100,453, in 1911. The salt production comes from

two principal districts—the northeastern, comprising Cuyahoga, Medina, Summit, and Wayne counties, and the southeastern, comprising Meigs and Morgan counties. The salt is all obtained by the evaporation of brine. The grainer process is most generally used in Ohio. The other commercial mineral products of Ohio are mineral waters, pyrite as a by-product of coal mining, sand-lime brick, and sulphuric acid from zinc smelting. The total value of the mineral products of Ohio increased from $97,090,284 in 1911 to $111,229,656 in 1912, distributed by substances as shown in the following table:

Mineral production of Ohio in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bromine....pounds..	.....	.....	116,872	$17,737	.....	.....	106,178	$18,836
Calcium chloride, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Cement.....barrels..	.....	.....	1,488,074	1,248,109	.....	.....	1,422,120	1,202,513
Clay products, short tons.....	285,735	b $206,668	.....	32,663,895	356,448	b $262,755	.....	34,811,508
Coal.....short tons..	30,759,986	31,810,123	.....	.....	34,528,727	37,083,363	.....	.....
Coke.....do....	.....	.....	311,382	b 961,904	.....	.....	388,669	b 1,365,905
Ferro-alloys, long tons	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Grindstones and pulp stones.....	.....	.....	.....	742,107	.....	.....	.....	787,621
Gypsum.short tons..	(a)	.....	.....	(a)	262,551	.....	.....	812,388
Iron ore...long tons..	16,697	30,549	.....	.....	20,861	40,986	.....	.....
Iron, pig.....do....	.....	.....	5,371,378	b73,484,592	.....	.....	7,127,176	b93,140,369
Lime.....short tons..	.....	.....	405,562	1,607,524	.....	.....	464,479	1,929,584
Mineral waters, gallons sold.....	1,958,547	86,478	.....	.....	2,709,745	117,287	.....	.....
Natural gas.....	.....	9,367,347	.....	.....	.....	11,891,299	.....	.....
Oilstones and scythestones.....	.....	.....	.....	(a)	.....	.....	.....	17,253
Petroleum...barrels..	8,817,112	9,479,542	.....	.....	c8,969,007	c12,085 998	.....	.....
Pyrite....long tons..	6,471	18,017	.....	.....	14,487	43,853	.....	.....
Salt.....barrels..	.....	.....	4,302,507	1,100,453	.....	.....	5,269,179	1,364,136
Sand and gravel, short tons.....	5,281,637	2,104,776	.....	.....	5,874,412	2,304,968	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone.....	.....	(d)	.....	d 5,796,829	.....	(d)	.....	d 6,197,388
Sulphuric acid (60° Baumé), e short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Miscellaneous.....	.....	.....	.....	1,338,348	.....	.....	.....	901,524
Total value, eliminating duplications..	$97,090,284				$111,229,656			

a Value included under "Miscellaneous."
b Value not included in total value.
c Includes production of Michigan, value of which is not included in Ohio State total.
d Stone sold rough included in derived product.
e From zinc smelting.

OKLAHOMA.

Much prominence has been given to Oklahoma as a mining State during the last few years by the remarkable increase in the production of petroleum which followed the discovery of oil in quantity in that State in 1904. It now ranks second among the States in the production of petroleum, being exceeded only by California. The first production of oil reported from Oklahoma (then Indian Territory) was in 1891, when an output of 30 barrels for the year was reported. Up to the close of 1902 the production had not amounted

to as much as 50,000 barrels, the maximum output during that period being 37,100 barrels (in 1902). In 1903 it reached nearly 140,000 barrels, but the real development began in 1904 when, as a result of considerable drilling in the Osage Indian Reservation and in the vicinity of Bartlesville and Ramona in the Cherokee Nation (then Indian Territory), the production rose to nearly 1,400,000 barrels. In the following year it was nearly 10,000,000 barrels and in 1906 the production was about double that of 1905. By 1908 it again more than doubled, with a production of nearly 46,000,000 barrels. The maximum output of 56,069,637 barrels was obtained in 1911. In 1912 the production decreased to 51,427,071 barrels. The value of the product, however, notwithstanding the decrease in quantity, increased over $8,000,000, from $26,451,767 in 1911 to $34,672,604 in 1912. The decreased production was in spite of a considerable development of oil and gas territory during the year, the most important features of which were the eastern extension of the Glenn pool and the somewhat phenomenal development of the Cushing pool in Creek County. Drilling in Stephens County resulted in the discovery of a considerable quantity of gas with smaller quantities of oil, and this new district may prove an important producer of both gas and petroleum in the future. The outlook at the end of 1912 was for active wildcatting in many portions of the State as well as much greater development of the already proved areas.

Oklahoma ranks third in quantity and fourth in the value of natural gas, the output in 1912 amounting to 73,800,000,000 cubic feet, valued at $7,406,528, against 67,300,000,000 cubic feet in 1911, valued at $6,731,770. Ohio, with a production of natural gas less than that of Oklahoma by 17,000,000,000 cubic feet in 1912, exceeded Oklahoma in point of value by nearly $4,500,000. The great increase in the production of petroleum, which has been used largely for fuel, naturally retarded the development of the coal resources of the State. From 1880, when according to the Tenth Census the production of coal in (then) Indian Territory was 120,947 tons, the output increased nearly every year until 1903, when it amounted to 3,517,388 tons. At this time the influence of petroleum and of natural gas began to be felt and coal production has remained practically stationary. With the decreased production of petroleum in 1912, the output of coal increased from 3,074,242 short tons, valued at $6,291,494, in 1911 to 3,675,418 short tons, valued at $7,867,331 in 1912, this being the maximum tonnage in the history of this Territory and State. The average production of coal in Oklahoma in the 10 years from 1903 to 1912, inclusive, has been 3,145,459 tons. The production in 1912 was 529,959 tons more than the average for the decade. Prior to the admission of Oklahoma as a State the principal production of coal was from the Choctaw Nation, with smaller quantities from Cherokee and Creek nations. Pittsburg County is now the leading producer, with Coal, Okmulgee, and Latimer in the order named. Six other counties also produce coal. The total value of the three fuels—coal, petroleum, and natural gas—in 1912 was $49,946,463, or 93 per cent of the total mineral output of the State. The only other product which had a value exceeding $1,000,000 in 1912 was that of cement. As there are only two manufacturers in the State the details of pro-

duction are not published. Ottawa County, in the northeastern part of the State, has developed some importance in the production of lead and zinc. It forms a part of the lead-zinc region of the Joplin district of southwestern Missouri. The zinc contents of the ores produced in Oklahoma were 5,769 short tons, valued at $796,122 in 1912, and 5,150 short tons, valued at $587,100 in 1911. The lead contents of the ores produced in Oklahoma were 2,501 short tons, valued at $225,090 in 1911, and 3,388 short tons, valued at $304,920 in 1912.

The clay products of the State are chiefly common and vitrified brick, the total value in 1911 being $756,639 and in 1912 $535,318. The principal counties in the utilization of clay resources are Muskogee, Rogers, and Tulsa.

The chief quarry product is limestone which is used for railroad ballast and concrete. The quarrying of granite, chiefly for building purposes, was also of considerable importance in Greer, Johnston, Kiowa, and Sequoyah counties. The total value of the stone produced decreased from $795,879 in 1911 to $429,788 in 1912.

Other mineral products of Oklahoma are asphalt, gypsum, lime, commercial mineral waters, pyrite, salt, sand, and gravel, and sand-lime brick. The total value of the mineral production of Oklahoma increased from $43,036,253 in 1911 to $53,614,130 in 1912. The distribution by substances is shown in the following table:

Mineral production of Oklahoma in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	(a)	(a)	.....	.....	(a)	(a)	(a)	(a)
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products.....	.....	.....	.....	$756,639	.....	.....	.....	$535,318
Coal.....short tons..	3,074,242	$6,291,494	.....	.....	3,675,418	$7,867,331	.....	.....
Gypsum.....do....	108,653	.....	.....	293,302	135,074	.....	.....	268,618
Lead.....do....	.....	.....	2,501	225,090	.....	.....	3,388	304,920
Lime.....do....	.....	.....	3,472	14,603	.....	.....	2,651	13,538
Mineral waters, gallons sold.....	497,074	14,290	.....	.....	1,015,512	32,971	.....	.....
Natural gas.....	.....	6,731,770	.....	.....	.....	7,406,528	.....	.....
Petroleum.....barrels..	56,069,637	26,451,767	.....	.....	51,427,071	34,672,604	.....	.....
Pyrite.....long tons..	(a)	(a)	.....	.....	.....	.....	.....	.....
Salt.....barrels..	.....	.....	500	431	.....	.....	(a)	(a)
Sand and gravel, short tons.....	291,424	97,539	.....	.....	492,858	163,298	.....	.....
Sand-lime brick.....	.....	.....	.....	.....	.....	.....	.....	(a)
Stone.....	.....	(b)	.....	b795,879	.....	(b)	.....	b 429,788
Zinc.....short tons..	.....	.....	5,150	587,100	.....	.....	5,769	796,122
Miscellaneous.....	.....	(b)	.....	b776,349	.....	(b)	.....	b1,123,094
Total value, eliminating duplications.....	$43,036,253				$53,614,130			

a Value included under "Miscellaneous." b Raw product included in derived product.

OREGON.

Oregon has not risen to much prominence as a mining State, its production of only two substances having attained as much as $1,000,000 in any year, and there was no product which attained that

value in during 1912. In 1910, owing to the large amount of stone used by the Government in jetty-work construction, the value of the stone quarried in Oregon amounted to a little over $1,100,000. With the completion of the Government work the value fell off to $583,398 in 1911 and to $268,002 in 1912, the latter year being less than one-fourth of what it was in 1910. The principal stone used in this work was basalt.

In 1911 the clay products of the State had a value of $1,081,025, but there was a decrease of 32 per cent in the value of the clay products of 1912, the total for that year being $734,226. The clay products consisted principally of common brick.

The product of principal value in 1912 was gold, of which there were 37,251 fine ounces, valued at $770,041. In 1911 the gold output was 30,641 fine ounces, valued at $633,407. The sand (chiefly building) and gravel had a combined value of $499,030 in 1912, against $659,417 in 1911. From the foregoing it appears that gold was the only exception to a decrease in output of the chief mineral products of the State. Some coal (lignite) has been produced in Coos County for a good many years, but the competition with fuel oil from California has taken away its chief market in San Francisco. The production has decreased regularly since 1909, the output in 1912 being less than one-half of what it was in the earlier year.

Other mineral products of the State are copper, occasional gems, lead, lime, mineral waters, platinum, and silver. Some gypsum and ocher have been produced, but not during the last two years. The total value of the mineral products of Oregon decreased from $3,192,679 in 1911 to $2,553,549 in 1912. The distribution of the products of the State, by substances, is shown in the following table:

Mineral production of Oregon in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
Clay products..short tons..	1,283	[a] $7,053	.....	[b] $1,081,025	[a] [c]	[a] [c]	.....	[b] $734,226
Coal.....do....	46,661	108,033	.....	.....	41,637	$108,276	.....	.....
Copper.....pounds..	.....	.....	93,136	11,642	.....	.....	260,429	42,971
Gems and precious stones..	.....	.....	.....	50	.....	.....	.....	2,000
Gold...fine ounces (troy)..	.....	.....	30,641	633,407	.....	.....	37,251	770,041
Lead.....short tons..	.....	.....	.....	.....	.....	.....	20	1,768
Lime.....do....	.....	.....	4,557	38,216	.....	.....	6,164	39,323
Mineral waters, gallons sold.....	56,300	18,000	.....	.....	48,351	17,503	.....	.....
Platinum, fine ounces (troy).....	.....	.....	117	3,265	.....	.....	39	1,014
Sand and gravel, short tons.....	1,438,504	659,417	.....	.....	1,067,634	499,030	.....	.....
Silver..fine ounces (troy)..	.....	.....	45,221	23,967	.....	.....	57,081	35,105
Stone.....	.....	(d)	.....	[d] 583,398	.....	(d)	.....	[d] 268,002
Miscellaneous.....	.....	.....	.....	32,259	.....	(d)	.....	[d] 34,865
Total value, eliminating duplications....	$3,192,679				$2,553,549			

[a] Value not included in total value.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Raw product included in derived product.

PENNSYLVANIA.

Since the first records of mining statistics were written into the history of the United States, Pennsylvania has stood at the top of the list. Exclusive of the value of the pig iron and of coke, and of other derived or secondary products not included in the total made in the State, the value of Pennsylvania's mineral production is nearly one-fourth of that of the entire country, and is only about $5,000,000 less than the combined output of Illinois, West Virginia, Ohio, and California, the next four States in the value of their mineral production. The total value of the mineral production of Pennsylvania was $414,426,962 in 1911 and $445,790,022 in 1912. Pennsylvania holds the leadership primarily on account of the State's supremacy in the production of coal. In the combined value of the production of anthracite and bituminous coal Pennsylvania nearly equals the aggregate value of all the mineral products of West Virginia, Illinois, and Ohio, the second, third, and fourth States, respectively, in rank. In addition to being the premier State in the production of coal, Pennsylvania leads also in the production of cement, lime, mineral paints, sand, slate, and stone, and in the manufacture of coke and pig iron. It is second in the value of clay products and natural gas. The production of coal in Pennsylvania in 1911 amounted to 235,025,324 short tons, valued at $321,344,344, of which 90,464,067 short tons, valued at $175,189,392, were anthracite and 144,561,257 tons, valued at $146,154,952, were bituminous. In 1912 the production of anthracite decreased to 84,361,598 short tons, but the value increased to $177,622,626. The decrease in production was due to a six weeks' suspension on April 1, pending the adjustment of the wage agreements, and the increased value is assignable to the advances in wages which were granted in the settlement. The production of bituminous coal on the other hand increased to 161,865,488 short tons in quantity and to $169,370,497 in value. The output of bituminous coal in 1912 was nearly double that of anthracite, but the value of the anthracite exceeded that of bituminous coal by $8,250,000. The combined value of anthracite and bituminous coal in Pennsylvania in 1912 was $346,993,123, equivalent to about 50 per cent of the total value of the coal produced in the United States, and nearly 78 per cent of the total value of the mineral products of the State.

As is well known, the entire production of anthracite is from a limited area, less than 500 square miles in extent, in the eastern part of the State. Nearly one-half of the total production of coal in Pennsylvania has been from this small area, and 80 per cent or more was mined in three counties—Luzerne, whose output in normal years exceeds 30,000,000 tons; Lackawanna, exceeding 20,000,000 tons; and Schuylkill, which produces between 16,000,000 and 18,000,000 tons a year. Northumberland produces over 6,000,000 tons, Carbon about 3,000,000 tons, and approximately 3,000,000 tons is produced by the combined output of Columbia, Dauphin, Sullivan, Susquehanna, and Wayne. The bituminous coal fields extend over the greater portion of the western part of the State and have a total area of more than 14,000 square miles. About 70 per cent of the production of bituminous coal is from five counties—Fayette, with a production in 1912 exceeding 32,000,000 tons; Westmoreland, exceeding 30,000,000 tons;

Allegheny, producing about 19,000,000 tons; Cambria, approximately 17,600,000 tons; and Washington, which in 1912 exceeded 16,600,000 tons. Two other counties, Somerset and Indiana, exceeded 9,000,000 tons in 1912; and Clearfield had a production of nearly 8,000,000 tons, Jefferson of over 5,000,000 tons, and Armstrong of over 4,000,000 tons. Four other counties, Butler, Center, Clarion, and Elk, each produced over 1,000,000 tons in 1912. The first two counties mentioned, Fayette and Westmoreland, contain the famous Connellsville coking coal, which makes that region the greatest coke making center in the world.

Pennsylvania produces little iron ore, its output amounting to only about 500,000 long tons, but it has in the city of Pittsburgh and vicinity the largest iron-making district of the world. The iron ores are brought chiefly from the Lake Superior region. The production of pig iron in Pennsylvania as a whole amounted to 12,437,685 long tons, valued at $181,569,299, in 1912, against 9,581,109 long tons, valued at $136,328,507, in 1911. If the value of the pig iron made in Pennsylvania be added to its total annual mineral production, the total output for the State would be valued at over $600,000,000, nearly one-third of the total for the United States. As it is, excluding the pig iron, the value of Pennsylvania's mineral production is equal to nearly 25 per cent of the total for the country.

One of the most important of Pennsylvania's mineral products, value considered, is natural gas, although representing only 4 per cent of the State's total mineral output and 5 per cent of the combined value of the anthracite and bituminous coal. In 1910 Pennsylvania gave place to West Virginia as first in rank in the quantity and value of natural gas produced, but continues to rank first in the consumption of gas, making up the shortage in its own production by drawing from West Virginia wells. The production of natural gas in Pennsylvania increased over 3,280,000,000 cubic feet in 1912 as compared with 1911, with an increase in value from $18,520,796, in 1911, to $18,539,672 in 1912. The consumption of natural gas in Pennsylvania is more than 60,000,000,000 cubic feet in excess of its production. West Virginia consumes less than half of the gas produced in that State, about three-fifths of its output being piped into Pennsylvania and Ohio for consumption.

Up to 1894 Pennsylvania was the leading State in the production of petroleum. In 1895 it was exceeded by Ohio, the production of Pennsylvania having begun to decline in 1891 while Ohio was approaching its maximum, which was attained in 1896. In recent years West Virginia, Texas, California, Illinois, and Oklahoma have risen rapidly in the production of petroleum, and now Pennsylvania ranks eighth in the quantity of its oil output and fifth in value. The output of petroleum in Pennsylvania decreased from 8,248,158 barrels in 1911 to 7,837,948 barrels in 1912, but in sympathy with the general advance in prices the value increased from $10,894,074 to $12,886,752.

Pennsylvania ranks second among the States in the total value of its clay products, and these also constitute the second in importance value considered, of the State's mining industries. The value of the clay products increased from $20,270,033 in 1911 to $21,537,221 in 1912. Although ranking second in the total value of its clay prod-

ucts it is first in the production of brick and tile, but falls behind Ohio, New Jersey, West Virginia, and New York in the value of the pottery. Expressed in value, the output of fire brick is the most important of the clay products of Pennsylvania, the State's production being more than one-third of the entire production of the United States and about one-third of the value of all the brick and tile products of the State. The value of the fire brick produced in Pennsylvania in 1911 was $5,555,529 and in 1912 $6,178,870. Common brick is second in importance among the clay products and the State's production was valued at $4,963,232 in 1911 and $4,590,784 in 1912. The value of front brick increased from $2,111,492 in 1911 to $2,321,479 in 1912. All classes of brick, tile, and terra cotta are made in Pennsylvania and the total value of these products was $18,113,216 in 1911 and $19,408,681 in 1912. The pottery products also include all of the varieties made in the United States, amounting in 1911 to $2,156,817 and to $2,128,540 in 1912. The principal clay-producing counties of the State are Philadelphia, Clearfield, Allegheny, Cambria, Beaver, Huntingdon, Armstrong, Elk, Clinton, and Lawrence. Philadelphia County is the third largest common-brick producing center of the country, with the city of Philadelphia for the market. It is the principal producer of common brick in Pennsylvania, and Allegheny County, the home of Greater Pittsburgh, is second. Lawrence and Clearfield counties are the principal producers of vitrified brick, and front brick is made chiefly in Armstrong County.

The Lehigh cement district of eastern Pennsylvania, with a few plants in New Jersey, is the most important cement-making region in the world. In Pennsylvania the principal producing center is in the vicinity of Allentown. The Lehigh district as a whole makes nearly one-third of the cement production of the United States, and includes the counties of Northampton, Carbon, Lehigh, and Berks in Pennsylvania, and Warren County in New Jersey. Other plants in Pennsylvania are located at York, Pittsburgh, Wampum, and Newcastle. The total production of cement in Pennsylvania in 1911, including a small quantity of natural cement, was 27,024,725 barrels, valued at $19,306,349, against 27,625,340 barrels, valued at $18,945,835, in 1912, of which nearly 90 per cent was from the Pennsylvania portion of the Lehigh district. Pennsylvania is by far the leading State in the production of cement, with approximately one-third of the total output of the country.

The production of limestone is the principal factor in giving Pennsylvania first place as a producer of stone. The State is also first in the production of slate, of sand and gravel, and of lime. In 1911 the total value of the stone quarried in Pennsylvania, exclusive of slate and of limestone made into lime, was $8,147,505, and in 1912 it was $9,144,214. Of this the production of limestone represented $5,243,045 in 1911, and $6,017,308 in 1912. The principal use of limestone is for fluxing in the furnaces around Pittsburgh and Johnstown and in the eastern and central parts of the State, about 70 per cent of the total being used for this purpose. More than $1,000,000 worth of limestone is crushed annually for use in road making, railroad ballast, and concrete. Next in importance to limestone is sandstone, which, including bluestone, was valued at $1,133,309 in 1911 and $1,367,601 in 1912. Trap rock, granite, and

marble are also quarried. The leading counties in the production of limestone are Blair, Butler, Lawrence, and Lebanon; in sandstone, Allegheny, Dauphin, Huntingdon, Lawrence, Luzerne, Pike, Susquehanna, and Wyoming; in trap rock, Berks, Bucks, Delaware, Montgomery, and Northumberland; in granite, Chester, Deleware, Montgomery, and Philadelphia; in marble, Chester, Montgomery, and Northampton. In the production of slate Pennsylvania is credited with nearly 60 per cent of the total output of the United States. In 1911 the State's production of slate was equal to $3,431,351, and in 1912, $3,474,247. The principal slate-producing region of the State is in Northampton and Lehigh counties. York is next in importance, producing the famous Peach Bottom slate. Smaller quantities are produced in Carbon and Lancaster counties. Pennsylvania has nearly one-half the total number of lime producers in the United States, but its production is about 25 per cent of the total quantity and 20 per cent of the total value. In 1911 the lime production of Pennsylvania was 841,723 short tons, valued at $2,688,374, and in 1912, 849,159 short tons, valued at $2,679,420. Lime burning as an industry is scattered pretty well all over the State.

The combined production of sand and gravel in Pennsylvania in 1911 was 5,689,059 short tons, valued at $3,025,267, and increased to 6,509,333 short tons, valued at $3,371,513, in 1912. Building sand is the most important of this character of product in the State, but of more relative importance is the production of glass sand, in which Pennsylvania ranks first among the States. It ranks second in the production of molding sand. In the total value (although not in the total quantity) of the sand and gravel production Pennsylvania ranks first, the precedence in value being due to the high value of the glass sand as compared with the others.

In the manufacture of coke, as in the production of coal and the manufacture of pig iron, Pennsylvania ranks preeminently above all the other States, with 60 per cent of the production of coke. In 1912 the quantity of coke made in Pennsylvania was 27,438,693 short tons, valued at $56,267,838, against 21,923,935 short tons, valued at $43,053,367 in 1911. The principal counties, as is well known, are Fayette and Westmoreland, which include the Connellsville and Lower Connellsville districts.

Other mineral products of Pennsylvania are bromine, calcium chloride, copper, feldspar, gems (occasionally), graphite, millstones, mineral paints, including natural and zinc-lead pigments, mineral waters, pyrite, quartz, salt, sand-lime brick, sulphuric acid, talc, and insignificant quantities of gold and silver. The total value of the mineral products of the State in 1911 was $414,426,962 and in 1912 $445,790,022. The distribution of the products, by substances, is shown in the following table:

Mineral production of Pennsylvania in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Abrasives, artificial.....pounds..			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Briquets, fuel.....short tons..			94,426	b $223,613			55,491	b $143,720
Bromine.....pounds..			(a)	(a)			(a)	(a)
Calcium chloride.....short tons..			(a)	(a)			(a)	(a)
Cement.....barrels..			27,024,725	19,306,349			27,625,340	18,945,835
Clay products.....short tons..	329,197	b $567,622		20,270,033	462,605	b $741,484		21,537,221
Coal:								
Anthracite.....short tons..	90,464,067	175,189,392			84,361,598	177,622,626		
Bituminous.....do....	144,561,257	146,154,952			161,865,488	169,370,497		
Coke.....do....			21,923,935	b 43,053,367			27,438,693	b 56,267,838
Copper.....pounds..			(a)	(a)			(a)	(a)
Feldspar.....short tons..	13,284	101,090			9,451	71,287		
Ferroalloys.....long tons..			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Gems and precious stones				300				103
Gold.....fine ounces (troy)..			(a)	(a)				
Graphite, crystalline.....pounds..	(a)	(a)			(a)	(a)		
Iron ore.....long tons..	514,929	539,553			522,172	481,353		
Iron, pig.....do....			9,581,109	b 136,328,507			12,437,685	b 181,569,299
Lime.....short tons..			841,723	2,688,374			849,159	2,679,420
Millstones				(a)				(a)
Mineral paints:								
Natural pigments.....short tons..			26,749	262,520			33,326	284,082
Zinc-lead pigments.....do....			(a)	(a)			(a)	(a)
Mineral waters.....gallons sold..	2,327,732	216,819			2,192,106	204,906		
Natural gas		18,520,796				18,539,672		
Petroleum.....barrels..	8,248,158	10,894,074			7,837,948	12,886,752		
Pyrite.....long tons..	(a)	(a)			(a)	(a)		
Quartz.....short tons..	(a)	(a)			(a)	(a)		
Salt.....barrels..			(a)	(a)			(a)	(a)
Sand and gravel.....short tons..	5,689,059	3,025,267			6,509,333	3,371,513		
Sand-lime brick				(a)				36,970
Silver.....fine ounces (troy)..			(a)	(a)			(a)	(a)
Slate				3,431,351				3,474,247
Stone		(c)		c 8,147,505		(c)		c 9,144,214
Sulphuric acid (60° Baumé) d.....short tons..			(a)	(a)			(a)	(a)
Talc.....do....	(c)	(c)	(a)	(a)	(c)	(c)	(a)	(a)
Miscellaneous		99,147		11,181,613		36,855		16,675,284
Total value, eliminating duplications.....		$414,426,962				$445,790,022		

a Value included under "Miscellaneous." b Value not included in total value. c Raw product included in derived product. d From zinc smelters.

RHODE ISLAND.

The only mineral products to which Rhode Island has contributed during the last few years are stone, mineral waters, lime, soapstone, and the manufactures of clay. In former years some coal was mined in Rhode Island. During 1911 a considerable amount of money was expended in an effort to reopen and operate these mines in the vicinity of Portsmouth. Some material was produced in 1911, but the results were not encouraging. In 1912 operations were suspended, though a small tonnage was also taken out in that year. The work was started by the Rhode Island Coal Co., which was afterwards reorganized as the Portsmouth Coal Mining Co. The equipment at Portsmouth included a briquetting plant, and during 1911 more than 15,000 tons of briquets were manufactured at the plant. In 1912 about 4,000 tons of briquets were made, although the plant was shut down during most of the year. Some of the "Rhode Island anthracite" pertains more to the nature of graphite than anthracite, and considerable quantities of it have been used in place of graphite as furnace linings. On account of the fact that with the exception of stone and mineral waters there are less than three operators engaged in each of the other few industries in the State, these two are the only products for which the statistics can be separately published.

The value of the stone production decreased from $958,753 in 1911 to $768,067 in 1912. The sales of mineral waters decreased from 503,360 gallons, valued at $27,036, in 1911, to 466,893 gallons, with an increase in value to $29,126, in 1912.

The following table gives the quantity and value of the mineral production of Rhode Island for 1911 and 1912:

Mineral production of Rhode Island in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel..short tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Clay products	.....	.....	.....	(a)	.....	.....	.....	(a)
Coal.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Lime.....do....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold	503,360	$27,036	.....	.....	466,893	$29,126	.....	.....
Soapstone.....short tons..	(c)	(c)	(a)	(a)	(a)	(a)	.....	.....
Stone	.....	(c)	.....	c$958,753	.....	(c)	.....	c$768,067
Miscellaneous	.....	(c)	.....	c 323,867	.....	(c)	.....	c 153,222
Total value, eliminating duplications	$1,253,656				$934,292			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

SOUTH CAROLINA.

Up to the close of 1911 the most important mining industry in South Carolina was that of phosphate rock, but in 1912, owing to a decrease in the production of this material, and an increase in the

value of the clay products, the phosphate mining industry gave way to clay-working as first in rank. The phosphate mining industry of South Carolina does not have the same actual or relative importance at the present time that it had in the later years of the last century. Until the discovery of the phosphate beds in Florida in 1899 South Carolina enjoyed practically a monopoly in the production of phosphate rock. With the development of the more extensive beds in Florida, South Carolina soon lost its supremacy in the production of this substance. In 1894 the production of rock in Florida exceeded that of South Carolina, and the former State has continued to hold first place since that time. Two varieties of phosphate rock were produced in South Carolina, known as land rock and river rock, the names indicating the sources from which the rock was obtained. The river-bed deposits have practically been worked out and the land deposits are approaching exhaustion. In 1893 the production of phosphate rock in South Carolina reached its maximum, when the production was 502,564 long tons. In 1911 there were 169,156 long tons, valued at $673,156, and in 1912, 131,490 long tons, valued at $524,760. South Carolina now ranks third as a producer of phosphate rock, being exceeded not only by Florida, but by Tennessee. The discovery of the phosphatic character of the Tennessee deposits was not made until 1894, and the production of South Carolina fell behind Tennessee in 1898. The production of phosphate rock in South Carolina in 1912 was the smallest recorded in 38 years.

Exclusive of the value of the raw clay sold the clay products of South Carolina were valued at $704,563 in 1912, against $669,794 in 1911. By far the greater part of the output is from the brickyards, the value of common brick produced in 1912 being $663,550, and in 1911 $624,103. South Carolina is one of four States which produces a peculiar quality of clay used in the paper trade and known as paper clay. None of this production, however, is used within the State, but is shipped to manufacturers in the North. The production of paper clay in South Carolina in 1911 was 30,640 short tons, valued at $120,012, out of a total production of raw clay amounting to 31,585 short tons, valued at $124,063. In 1912 the total quantity of raw clay mined and sold was 47,638 short tons, valued at $162,974, of which 44,372 short tons, valued at $157,217, was paper clay. The entire output of paper clay in the State was from Aiken County.

South Carolina is one of two States in which monazite has been produced in commercial quantities, the other and more important producer being North Carolina. The production in the two States has exceeded 1,500,000 pounds, and the value has exceeded $160,000, but during the last two years, on account of heavy imports from Brazil, the production in both States has practically ceased. In 1910 the total production of monazite in North Carolina and South Carolina was 15,847 pounds, valued at $1,902; but in 1911 and 1912 no commercial production was reported, though a few thousand pounds of crude sand were mined in 1911 and stocked.

The gold production of South Carolina has shown considerable decrease in the last few years. Some ten years ago, or in 1902, the value of the gold produced in South Carolina exceeded $120,000; in 1911 it was a little more, and in 1912 a little less than $20,000. The Haile gold mine, in Lancaster County, has been the chief source of

South Carolina's gold production. The marked decrease in the last few years indicates the exhaustion of this property.

Besides the four substances discussed in the foregoing paragraphs, South Carolina produced barytes, fuller's earth, lime, manganese ore, mica, mineral waters, sand and gravel, silver, and building stone. The value of the building stone, which consists almost entirely of granite, decreased from $335,617 in 1911 to $263,905 in 1912.

The total value of the mineral products of South Carolina was $1,606,989 in 1912, against $1,803,579 in 1911, distributed by substances, as shown in the following table:

Mineral production of South Carolina in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)						
Clay products.....do....	31,585	b$124,063		$669,794	47,638	b$162,974		$704,563
Fuller's earth.....do....	(a)	(a)						
Gold....fine ounces (troy)..			987	20,408			818	16,915
Lime.....short tons..			(a)	(a)			(a)	(a)
Manganese ore...long tons..					(a)	(a)		
Mica..								(a)
Mineral waters, gallons sold.....	285,389	42,099			360,404	70,348		
Phosphate rock..long tons..	169,156	673,156			131,490	524,760		
Sand and gravel, short tons.....	227,612	30,303			104,965	14,846		
Silver..fine ounces (troy)..			11	6			47	29
Stone..		(c)		c335,617		(c)		c263,905
Miscellaneous.....		(c)		c32,196		(c)		c11,623
Total value, eliminating duplications.	$1,803,579				$1,606,989			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

SOUTH DAKOTA.

Gold mining in the Black Hills of Lawrence County is the main seat of the mining industry of South Dakota. The value of the gold produced in South Dakota represents more than 90 per cent of the total production of the State, and in the production of gold South Dakota ranks fifth among all the States. In 1911 the production of gold, most of which is from the Homestake mine in the Black Hills region, amounted to 359,904 fine ounces, valued at $7,439,874. In 1912 the production amounted to 381,745 fine ounces, valued at $7,891,370. The total value of the mineral products of South Dakota was $8,047,259 in 1911 and $8,436,240 in 1912.

In 1909 and 1910 South Dakota produced some tin, also from the region of the Black Hills. There was not, however, any commercial production of this metal in 1911 or 1912.

The other mineral products of the State are: Clay wares, gems (occasional), gypsum, lead, lime, lithium, mica, mineral waters, natural gas, sand and gravel, sand-lime brick, silver, and stone, the combined value of which in 1912 was $544,870, or 6.5 per cent of the total.

The following table gives the quantity and value of the mineral production of South Dakota in 1911 and 1912:

Mineral production of South Dakota in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				$61,365				$41,496
Gems and precious stones				1,644				642
Gold...fine ounces (troy)			359,904	7,439,874			381,745	7,891,370
Gypsum.....short tons	(a)			(a)	(a)			(a)
Lead.....do			32	2,894			11	1,028
Lime.....do			5,293	37,573			3,914	28,585
Lithium.....do	(a)	(a)			(a)	(a)		
Mica				(a)				(a)
Mineral waters, gallons sold	13,400	$2,410			(a)	(a)		
Natural gas		(a)				(a)		
Sand and gravel, short tons	92,757	41,286			545,622	$69,348		
Sand-lime brick				31,535				14,395
Silver...fine ounces (troy)			203,755	107,990			206,460	126,973
Stone		(b)		b148,190		(b)		b162,295
Miscellaneous		25,984		146,514		37,741		62,367
Total value, eliminating duplications.	$8,047,259				$8,436,240			

a Value included under "Miscellaneous." b Stone sold rough included in derived product.

TENNESSEE.

The most important mineral resource of Tennessee is coal, the value of which is equal to nearly 40 per cent of the State's mineral production, which increased from $17,899,882 in 1911 to $19,362,209 in 1912. These values in neither case include the value of pig iron produced, but do include the value of iron ore. The gain in 1912 over 1911 was $1,462,327, of which nearly 50 per cent was due to the increased value, but not increased production, of copper. The quantity of copper content in the ores mined in Tennessee decreased from 18,850,276 pounds in 1911 to 18,483,173 pounds in 1912, but the value increased from $2,356,285 to $3,049,724.

The production of coal, the most important product of the State, was not materially different from 1911 either in quantity or value, the production having amounted to 6,433,156 short tons, valued at $7,209,734, in 1911, and to 6,473,228 short tons, valued at $7,379,903, in 1912. All of the coal-producing counties are in the central-eastern part of the State, which is crossed in a northeast-southwest direction by the coal areas of the Appalachian system. The principal producing counties, Campbell and Claiborne, are at the northern end of the Tennessee coal field. This section produces the celebrated Jellico coal, highly prized as a steam and domestic fuel. Other important coal-producing counties are Marion, Anderson, Morgan, Hamilton, Grundy, Scott, and Rhea. All of the coal produced in the State is bituminous in character, some of it possessing excellent coking quality. Coke is made in 8 counties, and is consumed in the iron furnaces at Rockwood, at Dayton, and in the vicinity of Chattanooga. The production of coke increased from 330,418 short tons in 1911, valued at $797,758, to 370,076 short tons, valued at $951,853, in 1912. The output of the blast furnaces, which is not included in the total

mineral production, increased from 297,594 long tons, valued at $3,439,644, to 339,397 long tons, valued at $4,171,153, but did not reach the record made in 1910, when the production amounted to a little more than 400,000 tons, with a value of approximately $5,200,000. All of the iron ore mined in Tennessee is used at blast furnaces within the State, with fuel which is produced within the State. The iron ore occurs in close proximity to the coking materials, and is mined chiefly in Roane, Lawrence, Wayne, and Hickman counties. The ores mined are hematite and brown ore, approximately 60 per cent being hematite and 40 per cent brown ore. In 1911 the commercial product—that is, the ore sold or used—was 469,728 long tons, valued at $632,339, and in 1912 it was 416,885 long tons, valued at $564,443.

Tennessee is the only one of importance in the Eastern States in the production of copper, and ranks ninth in this respect among all the States, but when compared with the great copper production of Arizona, Montana, and Michigan the output of copper in Tennessee appears unimportant. The entire production of the State is from pyritic ores mined in Polk County and smelted at Ducktown. The agitation in the last two years against the emission of sulphur-laden fumes from the smelter stacks and the efforts of the operators to control them have resulted in the construction of plants for the recovery in the form of acid of the sulphur contained in the ore. The plant of the Tennessee Copper Co. was described in the report on the production of sulphur, pyrite, and sulphuric acid in Part II of Mineral Resources of the United States for 1911. This plant was begun in 1906, enlarged in 1910, and has a capacity of from 180,000 to 200,000 tons of 60° Baumé acid annually. Its production of acid in 1912 was a fair test of the capacity of the plant. The Ducktown Sulphur, Iron & Copper Co. (Ltd.) has also installed an acid-recovery plant at its works. Details of production are not published, however, as there are only two producers of the smelter acid in the State.

The mining of phosphate rock and the quarrying of stone are rivals for third place in importance among Tennessee's industries. In 1911 phosphate rock furnished the larger value, and in 1912 the credit belonged to the quarries. The extensive beds of phosphate rock in Tennessee were discovered in 1894, and Tennessee now ranks second in the production of this mineral substance, with an output exceeding $1,500,000 annually. The principal deposits occur in the central part of the State, in Hickman, Maury, Williamson, Perry, and Lewis counties, and are of three types, brown, blue, and white rock, the first being by far the most important commercially.

The principal quarry products are marble and limestone. Tennessee marbles have a high reputation for interior decoration, and approximately 75 per cent of the entire output of marble is sold for that purpose. Limestone is used chiefly for road making, railroad ballast, concrete, and furnace flux. The principal marble-producing counties are Blount and Knox; Hawkins, Loudoun, and Union counties also furnish small quantities. Those producing the larger part of the limestone are Campbell, Carter, Cheatham, Coffee, Davidson, Franklin, Giles, Grainger, Hamilton, Jefferson, Knox, Marion, Maury, Montgomery, Rhea, Roane, Sullivan, Trousdale, and Wilson. The total value of the stone production of Tennessee was $1,656,812

in 1912, of which $974,733 was the value of the marble and $673,329 the value of the limestone. In 1911 the stone production was valued at $1,498,798, of which $700,229 was marble and $798,369 was limestone.

The value of the clay products, which came fifth in the list of mineral products of the State, increased from $1,385,100 in 1911 to $1,501,016 in 1912. The chief clay products are common brick, sewer pipe, vitrified brick, front brick, and pottery; and of the total values given above, those for pottery (which ranks next to common brick in value) were in 1911 $197,139 and in 1912 $173,166. The principal counties in the production of brick are Davidson, Shelby, Hamilton, and Knox. Tennessee is an important producer of ball clay, a high-grade clay used in the manufacture of porcelain and white ware. In the quantity of ball clay produced Tennessee holds first place, though falling behind Florida in the value of the product. The total quantity of clay mined in the State and sold as clay was 49,653 short tons, valued at $104,277, in 1911, and 56,253 short tons, valued at $123,523, in 1912. Most of the clay sold in its raw state is shipped to other States for manufacture.

Less important but at the same time commercial products of Tennessee are barytes, bauxite, cement, gold, lime, mineral paints, commercial mineral waters, natural gas, quartz, sand and gravel, silver, sulphuric acid, and zinc. The distribution by substances of the mineral production of Tennessee in 1911 and 1912 is shown in the following table:

Mineral production of Tennessee in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)	.....	.....	3,718	$8,682	.....	.....
Bauxite.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	49,653	b$104,277	.....	$1,385,100	56,253	b 123,523	.....	$1,501,016
Coal.....do....	6,433,156	7,209,734	.....	.....	6,473,228	7,379,903	.....	.....
Coke.....do....	.....	.....	330,418	b 797,758	.....	.....	370,076	b 951,853
Copper.....pounds..	.....	.....	18,850,276	2,356,285	.....	.....	18,483,173	3,049,724
Ferro-alloys...long tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Gold..fine ounces(troy)..	.....	.....	562	11,621	.....	.....	400	8,265
Iron ore.....long tons..	469,728	632,339	.....	.....	416,885	564,443	.....	.....
Iron, pig.....do....	.....	.....	297,594	b3,439,644	.....	.....	339,397	b4,171,153
Lime.....short tons..	.....	.....	91,099	282,763	.....	.....	101,339	316,364
Mineral paints, natural pigments..short tons..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold.....	1,073,115	72,475	.....	.....	796,568	53,560	.....	.....
Natural gas.....	.....	300	.....	.....	.....	375	.....	.....
Phosphate rock, long tons.....	431,566	1,688,267	.....	.....	(a)	(a)	.....	.....
Quartz.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Sand and gravel....do....	1,117,309	518,542	.....	.....	1,181,967	516,298	.....	.....
Silver..fine ounces (troy)..	.....	.....	106,660	56,530	.....	.....	89,893	55,284
Stone.....	.....	(c)	.....	c1,498,798	.....	(c)	.....	c1,656,812
Sulphuric acid (60° Baumé) d..short tons..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Zinc.....do....	.....	.....	1,117	127,338	.....	.....	2,191	302,310
Miscellaneous.....	.....	49,703	.....	2,303,347	.....	1,703,980	.....	2,503,854
Total value, eliminating duplications.....	$17,899,882				$19,362,209			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.
d From copper smelters.

TEXAS.

Texas, the largest State in area and fifth in the number of inhabitants, is twenty-first in the value of its mineral production. It does not hold first place as a producer of any mineral or mineral substance, but ranks second in the production of asphalt and third in the production of quicksilver. Since the sensational strike of petroleum at Beaumont in 1901 that substance has had first place in the mineral products of the State, and Texas ranks fifth among all the States in the quantity of production and seventh in regard to value. The value of the petroleum product represents something more than one-third of the total for the State. The production increased from 9,526,474 barrels, valued at $6,554,552, in 1911, to 11,735,057 barrels, valued at $8,852,713, in 1912. The increased production was almost altogether from the Electra field in the northern part of the State where a large amount of development and wildcatting was carried on during the year. The production of the coastal districts of the State decreased from 7,275,281 barrels in 1911 to 6,459,528 barrels in 1912. The Electra field, which was first developed in April, 1911, increased from approximately 900,000 barrels in that year to 4,227,104 barrels in 1912, and the total production of the northern part of the State increased from 2,251,193 barrels to 5,275,529 barrels. In addition to the developments in the Electra field in Wichita County and the Petrolia field in Clay County there was considerable activity in Coleman County and in the northern part of Wichita County. There was no expansion of old pools or the development of new ones in the coastal region.

Second in importance, reckoned by the value of output, is coal, including lignite or brown coal, the combined production of these amounting to 2,188,612 short tons, valued at $3,655,744, in 1912, against 1,974,593 short tons, valued at $3,273,288, in 1911. This is the only State in the Union that produces considerable quantities of both bituminous coal and true lignite. The areas of true coal are much less in extent than those of true lignite, but contribute something less than one-half of the output and about 80 per cent of the total value. In 1912 the production of bituminous coal, mined in Eastland, Erath, Maverick, Palo Pinto, Webb, Wise, and Young counties, amounted to 1,197,907 short tons, valued at $2,774,956. The production of lignite was 990,705 short tons, valued at $880,788. The average price for bituminous coal was $2.31; the average price of lignite was 89 cents at the mines. Lignite mining operations have been carried on in Anderson, Bastrop, Fayette, Hopkins, Houston, Lee, Leon, Medina, Milam, Rains, Robertson, Shelby, Titus, Van Zandt, and Wood counties. The lignite areas extend in a belt from the Sabine to the Rio Grande, but the production is limited at present to 11 counties, among which the principal ones are Milam and Wood. The bituminous areas are somewhat scattered, the larger field being in the central part of the State and two smaller fields bordering on the Rio Grande.

The only other mineral products which contribute to the total value as much as $1,000,000 are asphalt, clay, cement, and natural gas. The clay products of Texas were valued at $2,886,068 in 1912, against $2,659,919 in 1911. The principal products are common brick, sewer pipe, front brick, pottery, and vitrified brick, the first

constituting about 55 per cent of the total. The principal clay-working counties are Ellis, Wilson, Bastrop, and Bowie.

The manufacture of Portland cement in Texas is practically a part of the history of the last five years. During that time the production has increased rapidly from less than 500,000 barrels in 1908 to 1,762,780 barrels in 1912. In 1911 the production was 1,509,771 barrels, which, compared with the production in 1912, shows an increase in the latter year of over 250,000 barrels. The value of the cement increased from $1,823,224 in 1911 to $2,062,124 in 1912. Raw materials for the manufacture of cement are abundantly distributed throughout the State. Present operations are confined to four plants, two near Dallas and one each at San Antonio and at El Paso.

The production of natural gas in 1912 was valued at $1,405,077, against $1,014,945 in 1911.

The asphalt production of Texas, which is principally residue obtained from the heavy asphaltic oils, amounted to 55,826 short tons, valued at $786,785, in 1911 and 88,097 short tons, valued at $1,384,640, in 1912.

The production of quicksilver is from Brewster County, in the western part of the State.

The principal quarry product is limestone, produced in Bell, Bexar, Comal, Coryell, El Paso, Erath, Grayson, Guadalupe, Jack, Jones, Kaufman, McCulloch, Nolan, Palo Pinto, Stephens, Travis, and Williamson counties, and is used for building, for fundations, for curbing and flag stones, for road making, for concrete, and for flux. Granite is produced in Burnet, El Paso, and Llano counties. The red granite of Burnet County has few equals in attractiveness in this country.

The other commercial mineral products of the State are copper, fuller's earth, occasional gems, gold, gypsum, iron ore, lead, lime, mineral waters, salt, sand and gravel, sand-lime brick, silver, and zinc. Some tin has been reported in the neighborhood of El Paso.

The total value of the mineral production increased from $18,798,837 in 1911 to $22,797,015 in 1912, 67 per cent of the increase being due to the larger production of petroleum and natural gas.

The following table gives the quantity and value of the mineral products of Texas in 1911 and 1912:

Mineral production of Texas in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	.....	.....	55,826	$786,785	6,435	$19,626	88,097	$1,384,640
Cement.....barrels..	.....	.....	1,509,771	1,823,224	.....	.....	1,762,780	2,062,124
Clay products..short tons..	2,070	[a] $9,480	.....	2,659,919	1,342	[a] 6,442	.....	2,886,068
Coal.....do....	1,974,593	3,273,288	.....	.....	2,188,612	3,655,744	.....	.....
Copper.....pounds..	.....	.....	.....	.....	.....	.....	721	119
Fuller's earth..short tons..	[b]	[b]	.....	.....	[b]	[b]	.....	.....
Gems and precious stones..	.....	.....	.....	2,600	.....	.....	.....	145
Gold...fine ounces (troy)..	.....	.....	1	21	.....	.....	3	63
Gypsum.....short tons..	179,625	.....	.....	491,685	160,863	.....	.....	356,579
Iron ore.....long tons..	.....	.....	.....	.....	[b]	[b]	.....	.....
Lead.....short tons..	.....	.....	61	5,526	.....	.....	33	2,939
Lime.....do....	.....	.....	43,064	218,007	.....	.....	45,529	236,101
Mineral waters, gallons sold.	1,637,932	158,367	.....	.....	1,292,992	151,395	.....	.....
Natural gas.....	.....	1,014,945	.....	.....	.....	1,405,077	.....	.....
Petroleum.....barrels..	9,526,474	6,554,552	.....	.....	11,735,057	8,852,713	.....	.....
Quicksilver.....flasks..	.....	.....	[b]	[b]	.....	.....	[b]	[b]
Salt.....barrels..	.....	.....	385,200	299,537	.....	.....	373,064	290,328
Sand and gravel, short tons.	1,048,352	543,866	.....	.....	716,468	384,942	.....	.....
Sand-lime brick.....	.....	.....	.....	[b]	.....	.....	.....	[b]
Silver..fine ounces (troy)..	.....	.....	424,394	224,929	.....	.....	406,067	249,731
Stone.....	.....	[c]	.....	[c] 588,777	.....	[c]	.....	[c] 680,365
Tin.....short tons..	.....	.....	5	4,226	.....	.....	.....	.....
Zinc.....do....	.....	.....	.....	.....	.....	.....	119	16,422
Miscellaneous.....	.....	[c]	.....	[c] 148,583	.....	13,211	.....	148,683
Total value, eliminating duplications....	$18,798,837				$22,797,015			

[a] Value not included in total value.
[b] Value included under "Miscellaneous."
[c] Raw product included in derived product.

UTAH.

Utah is unique among the States in the diversity of its production of precious and semiprecious metals. It does not rank first in the production of any of these metals, but it stands well among the leaders in the production of gold, silver, copper, lead, zinc, and vanadium minerals. In the production of silver it ranks second; it ranks third in the production of lead, fourth in the production of copper, sixth in the production of gold, and seventh in the production of zinc. Forty per cent of the total production of the State is from copper mines in Salt Lake County. The Tintic district, in Juab County, and the San Francisco district, in Beaver County, are less important copper producers. The copper content of the ores mined in Utah in 1911 was 146,960,827 pounds, valued at $18,370,103. In 1912 the production had decreased nearly 10,000,000 pounds, to 137,307,485 pounds, valued at $22,655,735. The silver production, which ranks next to copper in value, is principally from Juab, Summit, Watsatch, and Utah counties, with smaller productions from Salt Lake, Beaver, and Tooele counties. The production increased both in quantity and value from 12,473,787 fine ounces, valued at $6,611,107, in 1911, to 13,835,903 fine ounces, valued at $8,509,080, in 1912. The silver-producing counties are also the chief producers of

lead, and one-half of the silver production and 90 per cent of the lead production are from silver-lead ores. The lead content of the ores mined in Utah in 1911 was 68,248 short tons, valued at $6,142,354, which was increased to 70,156 short tons, valued at $6,314,001, in 1912.

Gold, the fourth in importance among the metals and consequently among the mineral products in the State, showed a decreased output in 1912, amounting in that year to 206,360 fine ounces, valued at $4,265,851, against 227,217 fine ounces, valued at $4,696,998, in 1911. The principal gold producing counties are Juab, Salt Lake, and Tooele counties, with smaller amounts from Utah, Summit, Beaver, Wasatch, Piute, Box Elder, Iron, Washington, and Millard counties. There was also a small scattered placer production from other counties. About 35 per cent of the gold obtained is from dry or siliceous ores, but most of the output is obtained in the refining of copper. Some of the lead and zinc ores also yield gold.

The zinc production was chiefly from middlings and concentrates from the Park City district, and contributes over $1,000,000 to the total mineral production. The output of zinc in 1911 was 8,920 short tons, valued at $1,016,895; in 1912 it was 8,534 short tons, valued at $1,177,635. The total value of the metal production of Utah in 1911 was $36,837,457 out of a total value of all mineral production of $43,774,331. In 1912 the metal production was $42,922,302 out of a total of $51,004,942.

The most important of the nonmetalliferous products was coal, and more than half of the value of the nonmetalliferous products is from the coal mines. The principal coal-producing county is Carbon, which contains part of the Uinta coal basin, extending through eastern Utah almost to the central part of Colorado. The developments are principally along the line of the Denver & Rio Grande Railroad. Some of the Carbon County coal possesses coking qualities, and from 400,000 to 600,000 tons of coal are made into coke annually, chiefly from slack. The production of coal increased 20 per cent, from 2,513,175 short tons, valued at $4,248,666, in 1911 to 3,016,149 short tons, valued at $5,046,451, in 1912. Of the total production in 1912 Carbon County produced 2,684,731 tons, or almost 90 per cent.

The manufacture of Portland cement began in Utah in 1910 with an output of 811,800 barrels, valued at $1,005,960. It decreased nearly 150,000 barrels in 1911, to 662,849 barrels, valued at $827,523, but increased again in 1912 to 760,668 barrels, valued at $937,119.

The clay products of the State are chiefly common brick and front brick, with smaller quantities of vitrified brick, drain and other tile, etc., and a little pottery. The value of the clay products, exclusive of pottery, increased from $548,955 in 1911 to $724,978 in 1912.

The principal stone quarried in Utah is limestone, a large part of which is used for flux in smelters, though some is used for foundation work and also for building. The limestone quarries are located principally in Cache, Morgan, Salt Lake, San Juan, San Pete, Tooele, and Utah counties. Relatively small quantities of sandstone and granite are also produced in the State.

The other mineral products are asphalt, gems, grindstones, gypsum, iron ore, lime, mineral waters, petroleum, phosphate rock, salt, sand and gravel, scythestones, sulphur, uranium, and vanadium ores. The total value of the mineral products of Utah increased from $43,774,331

in 1911 to $51,004,942 in 1912. The distribution by substances is shown in the following table:

Mineral production of Utah in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt....short tons..	30,846	$516,614	.....	.....	[a] 31,478	[a]$573,069	.....	.....
Cement.....barrels..	.....	.....	662,849	$827,523	.....	.....	760,668	$937,119
Clay products, short tons.....	3,776	[b] 9,241	.....	[c] 548,955	(b) (d)	(b) (d)	.....	[c] 724,978
Coal.....short tons..	2,513,175	4,248,666	.....	.....	3,016,149	5,046,451	.....	.....
Coke.....do....	.....	.....	(b) (d)	(b) (d)	.....	.....	(b) (d)	(b) (d)
Copper.....pounds..	.....	.....	146,960,827	18,370,103	.....	.....	137,307,485	22,655,735
Gems and precious stones.....	.....	.....	.....	4,625	.....	.....	.....	8,325
Gold, fine ounces (troy).....	.....	.....	227,217	4,696,998	.....	.....	206,360	4,265,851
Grindstones.....	.....	.....	.....	.....	.....	.....	.....	(d)
Gypsum...short tons..	(d)	.....	.....	(d)	45,665	.....	.....	143,304
Iron ore.....long tons..	34,528	123,302	.....	.....	7,280	22,586	.....	.....
Lead.....short tons..	.....	.....	68,248	6,142,354	.....	.....	70,156	6,314,001
Lime.....do....	.....	.....	11,681	74,770	.....	.....	20,325	111,291
Mineral waters, gallons sold.....	(d)	(d)	.....	.....	(d)	(d)	.....	.....
Petroleum....barrels..	(d)	(d)	.....	.....	.....	.....	.....	.....
Phosphate rock, long tons.....	(d)	(d)	.....	.....	(d)	(d)	.....	.....
Salt.....barrels..	36,242	14,244	236,178	157,024	56,836	29,393	226,457	125,341
Sand and gravel, short tons.....	144,857	25,889	.....	.....	76,850	28,595	.....	.....
Scythestones.....	.....	.....	.....	.....	.....	.....	.....	(d)
Silver, fine ounces (troy).....	.....	.....	12,473,787	6,611,107	.....	.....	13,835,903	8,509,080
Stone.....	.....	(e)	.....	[e] 215,657	.....	(e)	.....	[e] 249,782
Sulphur....long tons..	(d)	(d)	.....	.....	.....	.....	.....	.....
Uranium and vanadium ores..short tons..	.....	.....	(d)	(d)	.....	.....	(d)	(d)
Zinc.....do....	.....	.....	8,920	1,016,895	.....	.....	8,534	1,177,635
Miscellaneous.....	.....	43,311	.....	1,113,193	.....	87,417	.....	1,507,862
Total value, eliminating duplications.....	$43,774,331				$51,004,942			

[a] Exclusive of wurtzilite, value for which is included under "Miscellaneous."
[b] Value not included in total values.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value included under "Miscellaneous."
[e] Stone sold rough included in derived product.

VERMONT.

Vermont's principal claim to distinction as a mining State is in the output of its marble, granite, and slate quarries. Vermont is the leading State in the production of both marble and granite and second in the production of slate. The marble quarries are chiefly in Rutland County in the west-central part of the State and in the immediate vicinity of Rutland and Proctor, with smaller quarries in Franklin County in the northwestern part and Bennington County in the southwestern part of the State. The granite quarries are along the eastern border, the principal producing counties being Washington and Windsor, lying almost due northeast and southeast from the marble-producing region. The slate production is almost exclusively from Rutland County. The total production of stone, exclusive of slate in Vermont in 1911 was valued at $6,145,351, of which $3,394,930 was marble and $2,730,719 was granite. In 1912

the value of the stone produced was $6,581,203, of which $3,494,253 was marble and $3,074,306 granite. In discussing the granite quarrying operations of Vermont it should be stated that a large part of the stone produced is sold by the quarrymen in the rough. Three-fourths of the granite quarrymen sell their product in the rough, and values are consequently given for rough stone. It is only when stone is dressed at the quarries that the higher value of dressed stone is given in the Survey reports. Limestone, exclusive of the quantity burned into lime, to the value of $19,702 was produced in 1911 and $12,644 in 1912. Considerably more than three-fourths of the granite quarried in Vermont is used for monumental purposes, and about 20 per cent for building. Marble is used largely for interior work. The slate production was valued at $1,849,975 in 1912, against $1,624,941 in 1911. Including the lime and slate, the total value of the quarry products was $7,961,327 in 1911 and $8,636,587 in 1912, indicating that the quarries yield over 90 per cent of the State's total mineral production. If to this the value of the scythestones and talc and soapstone be added, the quarry products represent more than 97 per cent of the total value of the State's mineral output. The production of soapstone, including talc, was 29,488 short tons, valued at $200,015, in 1911, and 42,413 short tons, valued at $275,679, in 1912.

Considerable development of asbestos property has been in progress in Vermont during the last few years, and this promises to be an important industry in the State.

Less important products are clay products, feldspar, mineral paints, mineral waters, and sand and gravel. The total value of the mineral products of Vermont increased from $8,434,516 in 1911 to $9,113,912 in 1912.

The distribution by substances of the mineral production of Vermont during 1911 and 1912 is shown in the following table:

Mineral production of Vermont in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Clay products.....do..	(a) (b)	(a) (b)	.....	$86,466	(a) (b)	(a) (b)	.....	$79,266
Feldspar.....do....	.....	.....	.....	.....	(a)	(a)	.....	.....
Lime.....do....	.....	.....	37,333	191,035	.....	.....	39,572	205,409
Mineral paints, natural pigments.....short tons..	.....	.....	504	5,047	.....	.....	531	6,346
Mineral waters, gallons sold.....	25,200	$9,346	.....	.....	21,000	$8,280	.....	.....
Sand and gravel, short tons.....	104,852	52,540	.....	.....	97,476	13,296	.....	.....
Scythestones.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Slate.....	.....	.....	.....	1,624,941	.....	.....	.....	1,849,975
Stone.....	.....	(c)	.....	c6,145,351	.....	(c)	.....	c6,581,203
Talc and soapstone, short tons.....	(c)	(c)	c 29,488	c 200,015	.....	.....	42,413	275,679
Miscellaneous.....	.....	(c)	.....	c 164,672	.....	(c)	.....	c 124,504
Total value, eliminating duplications....	$8,434,516				$9,113,912			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

VIRGINIA.

In the variety of mineral substances produced on a commercial scale Virginia ranks high among the States, although it takes relatively low rank in the value of its production, being about midway between Pennsylvania, which stands first, and the District of Columbia, which comes last. Virginia is the leading State in the production of manganese ore and of pyrite and is the only State in which rutile is produced. It also ranks first in the production of soapstone, most of which is manufactured before being marketed into articles which resist heat and chemical action, such as hearthstones, mantels, griddles, sinks, etc. The product of particular value in the State is coal, which represents something more than 50 per cent of the total mineral value. An increase of nearly 1,000,000 tons in quantity and of over $1,200,000 in value was the principal feature of interest during 1912. The output in 1911 was 6,864,667 short tons, valued at $6,254,804, against 7,846,638 tons, valued at $7,518,576 in 1912. Virginia is credited with having produced the first coal mined in the United States from a small basin contained in Henrico and Chesterfield counties in the eastern part of the State, near Richmond. Coal was known to exist in this locality as early as 1710 and before the close of the century shipments were made from this region to some of the Northern States. With the development of the more abundant and higher grade coals of the Appalachian region the industry in the eastern part of the State lagged and for a number of years the mines were not in operation. They were reopened in 1910 and in 1911 were again at a producing stage. The chief production of coal, however, is in Wise, Tazewell, Lee, and Russell counties in the southwestern portion of the State, the area of which belongs to the Appalachian region. The mining of coal in southwestern Virginia was coincident with the first Survey report on the mineral resources of the United States. The first shipment from the Pocahontas district, in which Tazewell County lies, was made to Norfolk in 1883. In 1888 the production exceeded 1,000,000 tons. In 1892 the Wise County fields were opened and in 1897 the production from this new district exceeded that of Tazewell County. The mines in Lee County were opened in 1905 and development of properties in Russell County have been active during the last two or three years. The production in 1912 was the maximum up to that year.

Virginia's production of pig iron, which is not included in the total value, amounted in 1911 to 308,789 long tons, valued at $3,898,285, increasing in 1912 to 328,961 long tons, valued at $4,364,708. The production in 1912, although exceeding that of 1911 by approximately 20,000 tons, did not reach the tonnage reported in 1910, when 402,625 long tons of pig iron were made in Virginia blast furnaces. Most of the blast furnaces are located in the southwestern part of the State, convenient to the iron ores and fuels. The iron-ore production of Virginia, notwithstanding the increase in the production of pig iron, decreased from 610,871 long tons, valued at $1,146,188, in 1911, to 412,520 tons, valued at $903,130, in 1912, indicating that a considerable portion of the pig iron made was from ores mined outside the State. About 90 per cent of the iron ore produced within the State is brown ore, the other 10 per cent being chiefly hematite with a small

quantity of magnetite. No magnetite was reported as mined in 1912. The leading counties in the production of iron ore are Botetourt, Allegheny, Pulaski, and Wythe. The larger part of the production is used in the furnaces of the companies operating the mines.

Most of the coals mined in southwestern Virginia possess coking qualities, although two banks of ovens, one at Low Moor and one at Covington, are supplied with coal from the New River district in West Virginia. The total production of coke in Virginia increased from 910,411 short tons, valued at $1,615,609, in 1911 to 967,947 tons, valued at $1,815,975, in 1912. Most of the coke made in Virginia is shipped to furnaces outside the State. The value of the coke, like the value of the iron ore, is not included in the total mineral production.

Second in importance among the mineral products of Virginia are the manufactures of clay, with about 25 per cent of the value of the coal produced. The value of the clay products, exclusive of pottery, in Virginia in 1912 was $1,874,174, against $1,739,900 in 1911. Common brick represents 80 per cent of the total value and about 17 per cent is represented by the value of front brick. Small quantities of ornamental, fire brick, drain tile, and sewer pipe are also produced. Alexandria County, opposite Washington, in the District of Columbia, is the principal common brick producer, with Henrico County a close second in quantity and first in value. The former depends upon Washington for its principal market and the latter upon the city of Richmond.

The principal stones quarried in Virginia are granite and limestone, the chief operations for granite being in the vicinity of Richmond, in Henrico and Chesterfield counties, and the limestone is obtained from the counties in the Shenandoah Valley. The Richmond granite has a fair reputation as a building stone, although a large part of the production is made into paving blocks or crushed for use in road making, railroad ballast, and concrete. Considerable quantities of limestone are also used for these purposes, but large quantities are also consumed as flux in iron furnaces and for burning into lime. The total value of the stone produced in Virginia in 1911 was $821,798, of which $420,611 was the value of granite and $369,872 the value of limestone, exclusive of that used for lime burning. In 1912 the total value of the quarry product was $877,746, of which granite represented $470,657 and limestone $403,069. A small quantity of sandstone is also produced in the State. The lime kilns produced 132,133 short tons of lime, valued at $483,016, in 1911, and 124,711 tons, valued at $488,628, in 1912. To the value of the quarry products should also be added the value of the slate produced in the State, and this in 1911 amounted to $188,808 and in 1912 to $195,392, the output in 1912 being the largest ever recorded.

The production of iron pyrite, used in the manufacture of sulphuric acid (and one of the substances in which Virginia ranks first), amounted in 1912 to 162,478 long tons, valued at $621,219, against 150,800 tons, valued at $558,494, in 1911. The pyrite production is from Louisa, Carroll, and Prince William counties, in the order named.

The soapstone production, in which Virginia also ranks first, is from quarries in a belt extending in a northeast-southwest direction

in the central part of the State, and includes Fairfax on the north and Orange, Nelson, and Albemarle counties on the south. The production, including that of talc, in 1911 amounted to 26,759 short tons, valued at $660,926, decreasing to 25,313 tons, valued at $576,473, in 1912.

In the total value of commercial mineral waters sold Virginia ranks sixth among the States, the value of the waters sold in 1911 being $298,701, and in 1912, $349,255.

In former years Virginia was of considerable importance in the production of lead and zinc. Lead mining in the State began more than 150 years ago, the first operations being conducted at Austinville, in Wythe County. Zinc mining began at a much later date, the ores at Bertha, also in Wythe County, being discovered in 1876; mining began in 1879. The metal was of exceptional purity and was used largely by the United States Government as an alloy in coining. The deposits are now practically exhausted. The zinc content of the ores mined in Virginia in 1912 amounted to only 249 short tons, valued at $34,309, and the lead content of the ores was 235 short tons, valued at $21,106.

In addition to the mineral substances enumerated above the following commercial products are obtained in the State: Asbestos, barytes, cement, copper, feldspar, occasional gems, gold, gypsum, infusorial earth, manganese ores, mica, millstones, mineral paints (natural and zinc-lead pigments), rutile, salt, sand and gravel, and silver. The total mineral production of the State was valued at $13,713,566 in 1911 and $14,995,842 in 1912, distributed by substances, as follows:

Mineral production of Virginia in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	.....	.....	.....	.....	.....	.....
Barytes.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Briquets, fuel.....do....	.....	.....	.....	.....	.....	.....	(a) (b)	(a) (b)
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products..short tons..	10,666	b$3,087	.....	$1,739,900	2,599	b$2,006	.....	c$1,874,174
Coal.....do....	6,864,667	6,254,804	.....	.....	7,846,638	7,518,576	.....	.....
Coke.....do....	.....	.....	910,411	b1,615,609	.....	.....	967,947	b1,815,975
Copper.....pounds..	.....	.....	90,000	11,250	.....	.....	112,835	18,618
Feldspar.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Ferro-alloys.....long tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Gems and precious stones..	.....	.....	.....	.....	.....	.....	.....	35
Gold...fine ounces (troy)..	.....	.....	148	3,064	.....	.....	10	218
Gypsum.....short tons..	(a)	.....	.....	(a)	(a)	.....	.....	(a)
Infusorial earth.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Iron ore.....long tons..	610,871	1,146,188	.....	.....	412,520	903,130	.....	.....
Iron, pig.....do....	.....	.....	308,789	b3,898,285	.....	.....	328,961	b4,364,708
Lead.....short tons..	.....	.....	(a)	(a)	.....	.....	235	21,106
Lime.....do....	.....	.....	132,133	483,016	.....	.....	124,711	488,628
Manganese and magniferous ore.....long tons..	2,962	25,770	.....	.....	3,104	19,180	.....	.....
Mica.....	.....	.....	.....	(a)	.....	.....	.....	.....
Millstones.....	.....	.....	.....	17,635	.....	.....	.....	25,866
Mineral paints:								
Natural pigments, short tons.....	.....	.....	(a)	(a)	.....	.....	1,181	10,853
Zinc-lead pigments, short tons.....	.....	.....	.....	.....	.....	.....	(a)	(a)
Mineral waters, gallons sold.....	2,474,918	298,701	.....	.....	2,762,319	349,255	.....	.....
Pyrite.....long tons..	150,800	558,494	.....	.....	162,478	621,219	.....	.....
Rutile.....short tons..	.....	.....	.....	.....	.....	.....	275	27,500
Salt.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(c)
Sand and gravel, short tons..	553,996	204,170	.....	.....	689,266	291,773	.....	.....
Silver..fine ounces (troy)..	.....	.....	21	11	.....	.....	982	604
Slate.....	.....	.....	.....	188,808	.....	.....	.....	195,392
Stone.....	.....	(d)	.....	d821,798	.....	(d)	.....	d877,746
Talc and soapstone, short tons.....	(d)	(d)	d26,759	d660,926	(d)	(d)	d25,313	d576,473
Zinc.....short tons..	.....	.....	(a)	(a)	.....	.....	249	34,309
Miscellaneous.....	.....	14,688	.....	1,326,343	.....	2,676	.....	1,190,511
Total value, eliminating duplications....	$13,713,566				$14,995,842			

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Raw product included in derived product.

WASHINGTON.

Washington is the only State on the Pacific coast in which coal is the chief product, and it is the only one of the three Pacific coast States in which coal mining is an industry of any importance. In 1911, out of a total production valued at $15,865,277, the output of coal mines was $8,174,170; in 1912 the total value of the State's production was $15,347,313, and the coal output was $8,042,871. In quantity the production of coal has decreased in each of the last three years, amounting in 1910 to 3,911,899 short tons, in 1911 to 3,572,815 tons, and in 1912 to 3,360,932 tons. This decrease has been due to the competition with fuel oil from California. The advantages of fuel oil are so marked, particularly as a sparkless fuel in the heavily forested State of Washington, that transportation companies having their own coal mines are using oil in their locomotives from Port-

land and Puget Sound through and beyond the forested areas of the coast and Cascade region. The relatively higher value of the coal produced in 1912, as compared with 1911, was due to the fact that a greater proportion of the product was sold for domestic purposes, for which a higher price is obtained than when sold for manufacturing and transportation purposes. Coal mining began in Washington as early as 1860, when the United States Census reported an output of 5,374 short tons. In 1882, the first year of record by the annual volume, Mineral Resources of the United States, the production had increased to 177,340 tons. Active exploration of the coal areas of Washington began between 1880 and 1890 and the production exceeded 1,000,000 tons before the end of that decade. In another 10 years the production had doubled, amounting to over 2,000,000 tons, and reached the 3,000,000 ton mark in 1903. During the last 10 years the average production has been slightly in excess of 3,000,000 tons. Except for the competition of fuel oil in the markets tributary to the Washington coal fields the production of coal at the present time would probably be in excess of 5,000,000 tons. With the exception of a small area, known as the Roslyn field on the eastern edge of the Cascade Mountains in Kittitas County, the principal coal fields of Washington are in close proximity to Puget Sound, Seattle and Tacoma obtaining their fuel supply from mines less than 50 miles distant. The principal producing counties are King, Kittitas, and Pierce. Some of the Pierce County coal makes a fair grade of coke, and considerable quantities of coke are made at ovens located at Carbonado, Fairfax, and Wilkeson. All of the coal is washed before coking, and most of the coke is sold to the smelter at Tacoma, smaller quantities going to Portland and Seattle for foundry use.

Next to coal the chief mining industry of Washington is clay-working and the principal products are vitrified brick, common brick, sewer pipe, architectural terra cotta, and fireproofing, in the order named. The total value of the clay products has decreased in each of the last three years, from a maximum of $3,060,486 in 1909 to $2,388,870 in 1912. The decline in 1912 was principally in the value of the vitrified brick, common brick, and sewer pipe. King County, adjacent to the markets of Seattle and Tacoma, is the principal producing county, with an output valued at about 55 per cent of the State total. Other important counties are Spokane and Stevens.

The principal stone products of Washington are granite and sandstone, with smaller quantities of marble and limestone. The value of the quarry products decreased about $500,000 in 1912, as compared with 1911, or approximately 30 per cent, from $1,679,872 to $1,174,047, this decrease being attributable to the same cause as that in Oregon, less demand for stone used in jetty and breakwater construction by the Federal Government. The principal quarry product is granite, most of which is produced in Clarke, Cowlitz, King, Lewis, Pierce, Snohomish, Spokane, and Yakima counties. As indicated above, the principal use was for riprap in the jetty construction, about 60 per cent of the total being sold for this purpose. Considerable quantities are also used for building purposes and for road making. The use of the sandstone, which comes principally from Thurston County, is divided nearly equally between building and paving and riprap in jetty construction. Limestone, produced chiefly

in San Juan and Snohomish counties, is used chiefly for flux and for lime burning. The lime production decreased from 35,094 short tons in 1911, valued at $228,933, to 29,078 tons, valued at $206,032, in 1912.

The manufacture of cement was one of the industries which showed an increased output in 1912, the production in that year being 1,438,137 barrels, valued at $2,012,785, against 960,573 barrels, valued at $1,496,807, in 1911. This increase of cement production with a decreased output of stone made the manufacture of cement third in importance among the State's mining industries.

The gold production of Washington decreased from 41,006 fine ounces, valued at $847,677, in 1911, to 32,942 fine ounces, valued at $680,964, in 1912, the decline being partly made up by the increase in the production of silver from 243,781 fine ounces, valued at $129,204, to 413,538 ounces, valued at $254,326.

The digging of gravel, chiefly for concrete and railroad ballast, and of sand, principally for building purposes, are industries of some importance in the State. The quantity of sand and gravel produced decreased from 1,145,369 short tons in 1911 to 1,020,841 tons in 1912, but the value of the product increased from $338,400 to $345,289.

Other commercial mineral products of Washington are copper, gems (occasional), lead, mineral paints, mineral waters, sand-lime brick, tungsten ores, and zinc. The total value of the mineral products of the State decreased from $15,865,277 in 1911 to $15,347,313 in 1912, distributed by substances as shown in the following table:

Mineral production of Washington in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel..short tons	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Cement.....barrels	.....	.....	960,573	$1,496,807	.....	.....	1,438,137	$2,012,785
Clay products..short tons	1,187	b $2,753	.....	c2,840,372	1,570	b $5,000	.....	c2,388,870
Coal.....do	3,572,815	8,174,170	.....	.....	3,360,932	8,042,871	.....	.....
Coke.....do	.....	.....	40,180	b 216,262	.....	.....	49,260	b 279,105
Copper.....pounds	.....	.....	318,207	39,776	.....	.....	1,086,010	179,192
Gems and precious stones	.....	.....	.....	.....	.....	.....	.....	235
Gold...fine ounces (troy)	.....	.....	41,006	847,677	.....	.....	32,942	680,964
Lead.....short tons	.....	.....	424	38,186	.....	.....	64	5,732
Lime.....do	.....	.....	35,094	228,933	.....	.....	29,078	206,032
Mineral paints, natural pigments	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, galls. sold	148,800	14,654	.....	.....	156,171	17,542	.....	.....
Sand and gravel..... short tons	1,145,369	338,400	.....	.....	1,020,841	345,289	.....	.....
Sand-lime brick	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver...fine ounces (troy)	.....	.....	243,781	129,204	.....	.....	413,538	254,326
Stone	.....	(d)	.....	d1,679,872	.....	(d)	.....	d1,174,047
Tungsten ore (60 per cent concentrates) ..... short tons	.....	.....	(a)	(a)	.....	.....	.....	.....
Zinc.....short tons	.....	.....	10	1,174	.....	.....	.....	.....
Miscellaneous	.....	.....	.....	75,052	.....	.....	.....	99,428
Total value eliminating duplications	$15,865,277				$15,347,313			

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, value of which is included under "Miscellaneous."
d Stone sold rough included in derived product.

WEST VIRGINIA.

West Virginia, which ranks second among the States in the value of its mineral products, owes its position in this regard to its resources in and its production of solid, liquid, and gaseous fuels. There are comparatively few mineral products in the State, 17 substances, including coke and pig iron, comprising the list. In the production of coal West Virginia ranks second in the quantity and third in the value, outranking Illinois in tonnage, but outclassed by Illinois in value. It ranks fourth in the production of petroleum and stands well at the head of all the States in the production of natural gas. These three fuels represent more than 90 per cent of the total mineral production of the State as expressed in values, coal alone constituting over 50 per cent, natural gas more than 25 per cent, and petroleum 16 per cent. Although West Virginia stands second in the total value of its mineral production and although more than 90 per cent of that total is represented by its fuels, the State ranks comparatively low in the value of its manufactures. Probably not more than 20 per cent, certainly not more than 25 per cent, of the output of these fuels being consumed for useful purposes within the State. More than half of the natural gas produced is piped for consumption into Pennsylvania and Ohio. The principal consumption of coal in West Virginia is by the locomotives in the transportation of the product to consumers in other States. Little of the petroleum produced in West Virginia is refined within the State. What is true of the coal is also true of the coke made from West Virginia coal. Until 1912 the State ranked either second or third in the manufacture of coke, with Alabama as its only close rival. In 1912 West Virginia dropped to fourth place in the manufacture of coke, not because of a decrease in production but because of the rise of Indiana as a manufacturer of this product; and not only has Indiana taken precedence of West Virginia in the quantity and value of its coke, but it draws its chief supply of coking coal from West Virginia mines. In fact, more coke was made in other States from West Virginia coal in 1912 than was made in that State itself. The production of coke in West Virginia increased from 2,291,049 short tons, valued at $4,236,845, in 1911, to 2,465,986 tons, valued at $4,692,393, in 1912. The maximum production of coke in West Virginia was 4,112,896 tons in 1907. It is doubtful if this tonnage will be reached again at an early date, as the tendency is toward the manufacture of coke in by-product ovens at points of consumption rather than at beehive ovens in the vicinity of the mines, and as there are few points of consumption in West Virginia the quantity of its coal shipped to distant localities for coke making will increase and the coke made in the State will fall behind. The ovens which draw their supply of coal from West Virginia are located at Gary and Indianapolis, in Indiana; at Chicago and Joliet, in Illinois; at Detroit and Wyandotte, in Michigan; at Hamilton and Cleveland, in Ohio; and at Low Moor and Covington, in Virginia.

In the 30 years during which the volumes, Mineral Resources of the United States, have been published the coal production of West Virginia has increased thirtyfold. In 1882 the production of the State was placed at 2,240,000 short tons. The maximum production was reached in 1912, the year under review, with 66,786,687 short

tons, almost exactly 30 times the estimated production of 1882. In 1911 West Virginia produced 59,831,580 short tons, with an increase in 1912 of 6,955,107 tons. The value of the output in 1912 was $62,792,234, against $53,670,515 in 1911, a gain of $9,121,719. Coal is produced in 34 out of 55 counties in the State, the most important in production being Fayette, Kanawha, Logan, McDowell, Mercer, Mingo, and Raleigh in the southwestern part of the State, and Barbour, Harrison, Marion, Preston, Taylor, and Tucker in the northern part.

The value of the natural gas produced increased from $28,435,907 in 1911 to $33,349,021 in 1912, and petroleum from 9,795,464 barrels, valued at $12,767,293, to 12,128,962 barrels, valued at $19,927,721. The petroleum production is principally from Ritchie, Pleasants, Tyler, Wetzel, Harrison, and Kanawha counties. The increased production in 1912 was due to the development of the Blue Creek pool in Kanawha County, begun in September, 1911. Further increased production was from the development of the Falling Rock Creek pool and the Big Sandy district, both of which adjoin the Blue Creek pool. Considerable extensions of these areas are anticipated.

Next to fuels the clay products of West Virginia are the most important, and of these pottery represents more than two-thirds of the total. West Virginia is third among the States in the value of pottery products, being exceeded only by Ohio and New Jersey. Of the other clay products, vitrified brick is the most important, followed by common brick, tile, and fire brick. The first trial in the United States of vitrified brick as a paving material was made in Charleston, W. Va. The development of the pottery industry, which is centered in Hancock County, has had much to do with the increase in the value of the clay products of West Virginia during the last five years, the output in 1912 being about 60 per cent more than that of 1908. The total value of the clay products in 1912 was $4,775,874, of which pottery represented $3,365,166. In 1911 the total value of the clay products was $4,333,420 and the pottery $2,880,202. Hancock is also the principal county in the manufacture of vitrified brick.

The principal quarry products of the State are limestone and sandstone, the latter predominating in the proportion of about 4 to 1. The northern part of the Shenandoah Valley is particularly rich in limestone suitable for iron-furnace flux, and approximately 70 per cent of the limestone produced in the State is for this purpose. The sandstone industry of Preston County has greatly expanded, the quarries near Kingwood having found a ready market, and much of the material is now going to New York City and other points east. The other quarry product of the State is chiefly crushed stone, used for railroad ballast, road making, and concrete; a little is also used for building. The value of the quarry products was $1,164,877 in 1912, against $1,106,012 in 1911. Lime burning is an important industry in the Shenandoah Valley portion of the State, the quantity increasing from 179,966 short tons, valued at $536,660, in 1911, to 232,584 tons, valued at $734,644, in 1912.

The sand and gravel production increased in quantity from 749,391 short tons in 1911 to 849,864 tons in 1912, but decreased in value from $532,388 to $530,025. More than 50 per cent of this value is in the output of glass sand, a product in which West Virginia ranks second,

and next to Pennsylvania. The State furnishes a large quantity of this material from the regions of Berkeley Springs, Morgan County; Deckers Creek, Monongalia County; Craddock, Upshur County; and near Corinth, Preston County.

The less important mineral products of West Virginia are bromine, calcium chloride, cement, grindstones, iron ore, mineral waters, and salt. The total value of the mineral products of the State increased about 20 per cent, from $101,932,248 in 1911 to $123,872,358 in 1912, distributed by substances as shown in the following table:

Mineral production of West Virginia in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Aluminum....pounds							(a) (b)	(a) (b)
Bromine.....do			77,908	$12,322			52,827	$11,687
Calcium chloride, short tons			(a)	(a)			2,930	17,817
Cement.....barrels			(a)	(a)			(a)	(a)
Clay products, short tons	73,304	b $48,576		4,333,420	82,768	b $58,776		4,775,874
Coal.....short tons	59,831,580	53,670,515			66,786,687	62,792,234		
Coke.....do			2,291,049	b4,236,845			2,465,986	b4,692,393
Grindstones				(a)				(a)
Iron ore.....long tons	(a)	(a)			(a)	(a)		
Iron, pig.....do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lime.....short tons			179,966	536,660			232,584	734,644
Mineral waters, gallons sold	259,686	67,687			309,245	60,445		
Natural gas		28,435,907				33,349,021		
Petroleum.....barrels	9,795,464	12,767,293			12,128,962	19,927,721		
Salt.....do			183,379	78,805			139,121	66,023
Sand and gravel, short tons	749,391	532,388			849,864	530,025		
Stone		(c)		c1,106,012		(c)		c1,164,877
Miscellaneous		(c)		c4,415,847		(c)		c4,464,182
Total value, eliminating duplications	$101,932,248				$123,872,358			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

WISCONSIN.

The mineral product of chief value in Wisconsin is zinc, which represents something more than 30 per cent of the total value of the mineral products of the State. Wisconsin leads all of the other States except New York in the production of mineral waters, their value being, however, only about one-fifth that of the value of the zinc produced. The output of mineral waters in Wisconsin is chiefly from the Waukesha springs in Waukesha County, the commercial sales from these springs exceeding those of the historically more famous waters of Saratoga Springs, N. Y. The value of the mineral waters produced in Wisconsin in 1911 was $955,988, decreasing to $869,495 in 1912, although the quantity sold increased from 5,716,162 gallons to 6,045,719 gallons.

In the production of primary spelter Wisconsin ranks third among the States, but when the zinc content of the ores mined is considered,

New Jersey takes precedence over Wisconsin and the latter drops to fourth in rank. The zinc content of the ores mined in Wisconsin increased from 29,720 short tons, valued at $3,388,080, in 1911 to 33,050 short tons, valued at $4,560,900, in 1912. The zinc mines are situated in Grant, Iowa, and Lafayette counties. Second in importance among the mineral products of Wisconsin, exclusive of pig iron, is iron ore. As a producer of iron ore Wisconsin is included in the Lake Superior district, portions of the Menominee and Gogebic ranges extending from Michigan into Wisconsin. The latter is, however, far below Minnesota and Michigan in the quantity of iron ore produced, only about 2 per cent of the production of the Lake Superior region being credited to Wisconsin. The marketed production of iron ore in the State in 1912 was somewhat more than twice as much as it was in 1911, recovering to the tonnage mined in 1910. In 1911 the production was less than half that of 1910. Third in importance among the State's mineral products is that of the quarries, the principal stones produced being granite and limestone. Granite is quarried chiefly in Douglas, Green Lake, Marathon, Marquette, Marinette, Oconto, Waupaca, and Waushara counties. Nearly half of the value of the granite produced in Wisconsin is used in the manufacture of paving blocks, the only instance of this kind in granite quarrying in the United States. Next to the paving blocks the principal use for the granite quarried in Wisconsin is in connection with monumental work, relatively small quantities being reported as used for building purposes and as crushed stone. The total value of the granite quarried in 1911 was $1,382,309, and in 1912, $1,179,018. The limestone (exclusive of that burned into lime), valued at $848,363 in 1911 and at $853,477 in 1912, is quarried in Brown, Buffalo, Calumet, Columbia, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Iowa, Kewaunee, La Crosse, Lafayette, Manitowoc, Milwaukee Monroe, Outagamie, Ozaukee, Pierce, Racine, Rock, Sauk, Sheboygan, Trempealeau, Vernon, Walworth, Waukesha, Waupaca, and Winnebago counties. Over two-thirds of the limestone produced in the State is crushed for use in road making, as railroad ballast, and for concrete. The total value of the quarry products of Wisconsin in 1912, including besides granite and limestone, a small output of sandstone and quartzite, was $2,375,102 in 1911, decreasing to $2,211,847 in 1912. Wisconsin ranks third among the States in the production of lime, having in 1912 an output of 263,052 short tons, valued at $825,551, as compared with 250,638 short tons, valued at $961,558, in 1911. The only other product which exceeds $1,000,000 in annual value is that of the clay pits. The value of the clay products decreased from $1,158,139 in 1911 to $1,044,486 in 1912. The chief product is common brick, and the leading clay working county is Milwaukee, the city of the same name furnishing the market for the output. Wisconsin ranks fourth among the States in the production of pyrite used in the manufacture of sulphuric acid. As compared with other mineral products of the State the value contributed by this item is relatively unimportant. The other products in the order of their importance are sand and gravel, manganiferous ore, lead, sand-lime brick, quartz, mineral paints, and amorphous graphite. The secondary mineral products of considerable importance in the State, the output of which is not included in the total value, are pig iron, coke, zinc-lead pigments, and fuel briquets.

The following table gives the quantity and value of the mineral production of Wisconsin, by substances, during 1911 and 1912:

Mineral production of Wisconsin in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel..short tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Clay products.....do....	586	b $1,222	.....	$1,158,139	836	b $1,172	.....	$1,044,486
Coke.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Graphite, amorphous do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron ore.....long tons..	559,763	1,386,616	.....	.....	1,152,250	2,731,574	.....	.....
Iron, pig.....do....	.....	.....	245,152	b3,803,049	.....	.....	270,981	b3,883,125
Lead.....short tons..	.....	.....	3,353	301,770	.....	.....	2,581	232,290
Lime.....do....	.....	.....	250,038	961,558	.....	.....	263,052	825,551
Manganiferous ore, long tons.....	(c)	(c)	.....	.....	(c)	(c)	.....	.....
Mineral paints:								
Natural pigments, short tons.....	.....	.....	2,048	11,258	.....	.....	2,106	9,953
Zinc-lead pigments, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold.....	5,716,162	955,988	.....	.....	6,045,719	869,495	.....	.....
Pyrite.....long tons..	12,893	50,025	.....	.....	17,898	70,518	.....	.....
Quartz.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Sand and gravel.....do....	3,676,855	731,692	.....	.....	3,051,819	664,327	.....	.....
Sand-lime brick.....	.....	.....	.....	68,312	.....	.....	.....	70,795
Stone.....	.....	(d)	.....	d2,375,102	.....	(d)	.....	d2,211,847
Zinc.....short tons..	.....	.....	29,720	3,388,080	.....	.....	33,050	4,560,900
Miscellaneous.....	.....	30,418	.....	2,992,874	.....	34,368	.....	3,569,385
Total value eliminating duplications....	$12,032,158				$14,192,287			

a Value included under "Miscellaneous."
b Value not included in total value.
c Tonnage and value included in iron ore.
d Stone sold rough included in derived product.

WYOMING.

The only mineral product of much importance in Wyoming is coal, the value of which represents nearly 90 per cent of the total mineral production. The principal coal-mining operations are in Sweetwater, Uinta, Sheridan, Fremont, Carbon, Bighorn, Lincoln, and Western counties. Other coal-producing counties are Converse, Crook, Johnson, and Park. The total value of all mineral production in Wyoming in 1911 was $11,483,377, of which the coal production, amounting to 6,744,864 short tons, represented $10,508,863. In 1912 the total value of all mineral production in the State was $13,374,088, of which the coal production, 7,368,124 short tons, represented $11,648,088 in value.

Unlike most of the Rocky Mountain States, Wyoming is not an important producer of any of the metals, the total value of the copper, gold, and silver production in the State being less than $30,000, and the value of all mineral products outside of coal being about $1,700,000. The mineral products which contribute to this are asbestos, clay manufactures, gems and precious stones, gypsum, iron ore, lime, mineral waters, natural gas, petroleum, phosphate rock, sand and gravel, silver, stone, and sulphur. The development of the

extensive phosphate deposits in the southwestern part of the State gives promise of establishing an important industry there in the future.

The following table gives the quantity and value of the mineral production of Wyoming during 1911 and 1912:

Mineral production of Wyoming in 1911 and 1912.

Product.	1911				1912			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Clay products.....do....	(a) (b)	(a) (b)	.....	$77,146	(a) (b)	(a) (b)	.....	$45,103
Coal.....do....	6,744,864	$10,508,863	.....	.....	7,368,124	$11,648,088	.....	.....
Copper.....pounds..	.....	.....	118,584	14,823	.....	.....	27,570	4,549
Gems and precious stones...	.....	.....	.....	30	.....	.....	.....	50
Gold....fine ounces (troy)..	.....	.....	929	19,200	.....	.....	1,076	22,235
Gypsum.....short tons..	44,687	.....	.....	116,238	36,581	.....	.....	89,992
Iron ore.....long tons..	479,922	479,922	.....	.....	(a)	(a)	.....	.....
Lime.....short tons..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters.gallons sold..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Natural gas.....	.....	(a)	.....	.....	.....	(a)	.....	.....
Petroleum.....barrels..	(a)	(a)	.....	.....	1,572,306	798,470	.....	.....
Phosphate rock..long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Sand and gravel.short tons..	784,865	58,548	.....	.....	639,031	56,753	.....	.....
Silver...fine ounces (troy)..	.....	.....	725	384	.....	.....	265	163
Stone.....	.....	(c)	.....	c 40,544	.....	(c)	.....	c 68,479
Sulphur.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Miscellaneous.....	.....	d 168,379	.....	(d)	.....	d 642,101	.....	(d)
Total value, eliminating duplications.....	$11,483,377				$13,374,088			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.
d Derived product included in raw product.

SUMMARY OF THE MINERAL PRODUCTION OF THE UNITED STATES IN 1912.

Compiled by W. T. Thom.

GENERAL REMARKS.[1]

The different units of measurement employed in the mineral industry make it impossible to compare the outputs of the several minerals, except in the value of the products.

In 1905, for the first time, the total value of the domestic mineral production exceeded the enormous sum of $1,500,000,000; and in 1907 the still greater sum of $2,000,000,000 was exceeded, as it was again in 1912.

In 1908 the disastrous results of the financial depression of the latter part of 1907 became only too apparent in the decrease in value of the mineral output, which declined for the year to about $1,595,000,000 from over $2,000,000,000 in 1907. In 1909 the general recovery in business carried the value of the domestic mineral production up to $1,887,582,445. In 1910 the continued favorable business conditions raised the value again almost to the high level of 1907, the value in 1910 being $1,992,405,727. In 1911 there was a sharp decline in pig iron that brought the total value for the year down to $1,927,532,128. In 1912 the general swing of business carried the value of mineral production up to $2,243,630,326, a gain of $316,098,198, or 16.40 per cent, over the production of 1911.

As heretofore, iron and coal are the most important of our mineral products. The value of iron (pig iron being the basis of valuation) in 1912 was $420,563,388; the value of coal was $695,606,071. The fuels—coal, natural gas, and petroleum—increased from $835,231,497 in 1911 to $943,972,362 in 1912, a gain of $108,740,865. Anthracite coal showed an increase in value of $2,433,234 from $175,189,392 in 1911 to $177,622,626 in 1912. The increase in value of the bituminous coal output from $451,375,819 in 1911 to $517,983,445 in 1912 was $66,607,626.

The production of metals increased in value $186,571,303, or 27.42 per cent, from $680,531,782 in 1911 to $867,103,085 in 1912. The

[1] The imports cited in this summary and in the volume are "imports for consumption," which may or may not be identical with the "total imports" for the calendar year. Merchandise brought into the country late in December, for example, may be entered for consumption or it may be put into a warehouse and not be withdrawn for consumption until some months later. It will then be credited for consumption to the year of its withdrawal from the warehouse.

nonmetals increased $129,276,895, or 10.37 per cent, from $1,246,750,346 in 1911 to $1,376,027,241 in 1912. The unspecified products, including cadmium, rutile, selenium, uranium and vanadium, and other minerals, valued at $500,000, an increase in value of $250,000, bring the total value of the mineral production for 1912 up to $2,243,630,326.

The composition of this total gain in 1912 of $316,000,000 is worthy of note. Pig iron gained more than $93,000,000, or 28 per cent, an evidence of the good condition of the iron market; ferro-alloys, hitherto reported as and obscured under pig iron, gained nearly $4,000,000, or about 46 per cent, on a basis of report which the Survey regrets has not yet been made fully representative of production; silver gained more than $6,000,000, or about 20 per cent; copper gained about $68,000,000, nearly 50 per cent; zinc gained nearly $14,000,000, or 44 per cent; and aluminum gained nearly $4,000,000, or 47 per cent. Gold, which lost about $3,500,000, was the only important metal to show a decrease. Among the nonmetals, bituminous coal gained approximately $67,000,000, about 15 per cent; anthracite coal gained more than $2,000,000 in value, although it declined nearly 7 per cent in quantity of output; natural gas gained almost $10,000,000, or 13 per cent; petroleum gained nearly $30,000,000, or 22 per cent; clay products gained more than $10,000,000, or 6.5 per cent; and sulphuric acid from copper and zinc smelters (a product mined as it were out of the air and changed from a destructive waste to an absolute gain) increased $1,500,000, or 55 per cent.

It is also worthy of note that the total value for 1912 exceeded the hitherto unsurpassed total value for 1907 by almost $171,000,000, or 8.25 per cent. Judged by the record of mineral production, therefore, 1912 was a year of more general domestic welfare than 1907.

METALS AND ORES.

Metals and metallic ores.—The report on this subject was published for the first time in this series in the volume for 1909. The output of metals in the United States in 1912 from domestic ores was valued at $839,146,642, from foreign sources at $156,651,976, the total value being $995,798,618; the output in 1911 from domestic ores was valued at $661,088,422, from foreign sources at $126,639,354, the total value being $787,727,776; the output in 1910 from domestic ores was valued at $723,523,271, from foreign sources at $151,934,355, the total value being $875,657,626, including undistributed. The output of crude metallic ores of all kinds from domestic mines amounted in 1909 to 111,900,807 short tons, in 1910 to 120,367,082 short tons, in 1911 to 105,380,370 short tons, and in 1912 to 130,728,622 short tons.

Iron and steel.—Twenty States produced and marketed pig iron (exclusive of ferro-alloys) in 1912 against 21 States in 1911. The total marketed production of pig iron in 1912 was 30,180,969 long tons, valued at $420,563,388, as compared with 23,257,288 long tons, valued at $327,334,624, in 1911, and with 26,674,123 long tons, valued at $412,162,486, in 1910. The average annual output and value for the five years from 1905 to 1909, inclusive, was 23,162,484 long tons,

valued at $418,321,000. The production in 1912 showed an increase in quantity of 6,923,681 long tons, or 29.77 per cent, over the production of 1911, and an increase in value from $327,334,624 to $420,563,388, amounting to $93,228,764, or 28.48 per cent. The average price per long ton of pig iron rose from $19.98 in 1906 to $20.56 in 1907, fell to $15.96 in 1908, rose to $16.25 in 1909, fell to $15.57 in 1910, to $14.07 in 1911, and to $13.93 in 1912.

Iron ore.—The marketed production of iron ore in 1912 amounted to 57,017,614 long tons, valued at $107,050,153, as compared with 41,092,447 long tons, valued at the mines at $86,716,575, in 1911. As in the 13 preceding years, the production of iron ore in the United States in 1912 was not equaled by that of any other country. The general imports of iron ore in 1912 were valued at $6,499,690, against $5,412,636 in 1911, against $7,832,225 in 1910, and against $3,154,081, the average annual value for the five years from 1905 to 1909. The exports in 1912 were valued at $3,537,289, against $2,653,448 in 1911, against $2,474,164 in 1910, and $1,365,325 in 1909.

Ferro-alloys.—The United States Geological Survey undertook for the first time in the iron report for 1911 to present the statistics of production of ferro-alloys separately from those of pig iron, with which they had been included.

As reported, the marketed production of ferro-alloys in 1912 was 328,685 long tons, valued at $12,223,776, as compared with 253,375 long tons, valued at $8,377,832, in 1911. The greater part of the production is from foreign ores. The quantity reported does not represent the total production of the United States, as considerable quantities of electrically produced ferro-alloys were not reported to the Survey.

The Bureau of Foreign and Domestic Commerce reports the following values of imports for consumption of ferro-alloys in 1912 and 1911: Chrome and ferrochrome, $77,587 in 1912, against $27,902 in 1911; ferrophosphorus, $4,465, against $8,520; ferrosilicon, $446,456, against $341,681; ferromanganese, $3,906,920, against $3,015,062; ferrovanadium, none in 1912, $2,623 in 1911; molybdenum and ferromolybdenum, $4,670, against $11,409; spiegeleisen, $28,094, against $405,444; titanium and ferrotitanium, $7,631, against $22,500; tungsten and ferrotungsten, $323,872, against $143,802—a total of $4,799,695 in 1912, against $3,978,943 in 1911.

Manganese ore.—The marketed production of manganese ore in 1912 was 1,664 long tons, valued at $15,723, as compared with 2,457 long tons, valued at $24,586, in 1911, with 2,258 long tons, valued at $22,892, in 1910, with 1,544 long tons, valued at $19,675, in 1909, and with 5,187 long tons, valued at $55,992, the average annual production for the five preceding years. The average price per ton was $12.73 in 1906, $11.31 in 1907, $10.22 in 1908, $12.74 in 1909, $10.14 in 1910, $10.01 in 1911, and $9.45 in 1912. Manganiferous ore, carrying from 20 to 40 per cent of manganese, was marketed in 1912 to the extent of 51,517 long tons, valued at $19,942, against 44,437 long tons, valued at $114,918, in 1911, against 61,101 long tons, valued at $186,765, in 1910, and against 68,654 long tons, valued at $215,925, in 1909. The imports for consumption of manganese ore in 1912 were 300,661 long tons, valued at $1,769,184, against 176,852 long tons, valued at $1,186,791, in 1911.

Gold.—The production of gold was 4,520,717 fine ounces, valued at $93,451,500, in 1912, as compared with 4,687,053 fine ounces, valued at $96,890,000, in 1911, and with 4,657,018 fine ounces, valued at $96,269,100, in 1910, and with 4,520,389 ounces, valued at $92,804,-720, the average annual production for the preceding five-year period. The decease in 1912 was 166,336 fine ounces, valued at $3,438,500.

Silver.—The production of silver in 1912 was 63,766,800 fine ounces, valued at $39,197,500, as against 60,399,400 fine ounces, valued at $32,615,700, in 1911, as against 57,137,900 fine ounces, valued at $30,854,500, in 1910, and against 55,259,300 ounces, valued at $33,256,780, the average yearly production for the five years from 1905 to 1909, inclusive. The increase in 1912 was 3,367,400 fine ounces, valued at $6,581,800.

Copper.—The production of copper in 1912 was 1,243,268,720 pounds, valued at $205,139,338, as against 1,097,232,749 pounds, valued at $137,154,092, in 1911, as against 1,080,159,509 pounds, valued at $137,180,257, in 1910, and against 942,221,757 pounds, valued at $151,131,959, the average production for the five-year period ending with 1909. The general imports in 1912 were valued at $57,012,057, as against $38,525,939 in 1911, as against $40,849,239 in 1910, and $39,642,679 in 1909. The exports in 1912 were valued at $129,973,387, against $105,679,926 in 1911, and against $96,554,432 in 1910.

Lead.—The production of lead in 1912 was 415,395 short tons, valued at $37,385,550, as compared with 405,863 short tons, valued at $36,527,670, in 1911, and with 389,211 short tons, valued at $34,250,568, in 1910. The imports for consumption of lead ore were valued at $605,551 in 1912, as against $631,654 in 1911, against $755,092 in 1910, and $861,506 in 1909. The exports of manufactures of lead were valued at $651,459 in 1912, at $680,419 in 1911, and at $614,158 in 1910. The imports of type metal were valued at $18,668 in 1912, at $310,658 in 1911, at $485,493 in 1910, and at $532,108 in 1909.

Antimonial lead.—The production of antimonial lead in 1912 was 13,552 short tons, valued at $1,311,348, as against 14,078 short tons, valued at $1,380,556, in 1911, as against 14,069 short tons, valued at $1,338,090, in 1910, and 12,896 short tons, valued at $1,231,019, in 1909.

Zinc.—The production of zinc in 1912 was 323,907 short tons, valued at $44,699,166, as compared with 271,621 short tons, valued at $30,964,794, in 1911, with 252,479 short tons, valued at $27,267,732, in 1910, with 230,225 short tons, valued at $24,864,300, in 1909, and with 200,948 short tons, valued at $22,283,873, the average annual production for the five-year period ending with 1908. The imports for consumption of zinc, including zinc dust and zinc ores, were valued at $1,952,011 in 1912, at $408,299 in 1911, and at $990,065 in 1910; the exports of domestic zinc ore, zinc dust, and manufactures of zinc were valued at $1,846,301 in 1912, at $1,935,677 in 1911, at $1,558,271 in 1910, and at $1,222,173 in 1909.

Bauxite.—In 1912 the production of bauxite was 159,865 long tons, valued at $768,932, as compared with 155,618 long tons, valued at $750,649, in 1911, as compared with 148,932 long tons, valued at $716,258, in 1910, and with 83,717 long tons, valued at $421,955, the average annual production for the five-year period from 1905 to 1909. The imports for consumption in 1912 were 26,214 long tons, valued at $95,431, as against 43,222 long tons, valued at $164,301, in 1911, as

against 15,669 long tons, valued at $65,743, in 1910, and 18,688 long tons, valued at $83,956, in 1909.

Aluminum.—The consumption of aluminum during 1912 was 65,607,000 pounds, valued at $11,907,000, as against 46,125,000 pounds, valued at $8,084,000, in 1911, as against 47,734,000 pounds, valued at $8,955,700, in 1910, and against 17,766,000 pounds, valued at $4,288,600, the average annual consumption for the period from 1905 to 1909. The imports for consumption of aluminum salts were valued at $84,606, in 1912, as against $56,833 in 1911, against $53,671 in 1910, and $29,061 in 1909. The exports of manufactures of aluminum were valued at $1,347,621 in 1912, at $1,158,603 in 1911, at $949,215 in 1910, at $567,375 in 1909, and at $330,092 in 1908.

Quicksilver.—The production of quicksilver in 1912 amounted to 25,064 flasks, valued at $1,053,941, as against 21,256 flasks, valued at $977,989, in 1911, as against 20,601 flasks, valued at $958,153, in 1910, and against 21,075 flasks, valued at $957,859, in 1909. California reported 20,524 flasks in 1912, as against 18,860 flasks in 1911, against 17,211 flasks in 1910, and 16,078 flasks in 1909. Texas and Nevada reported 4,540 flasks in 1912, against 2,396 flasks in 1911, and 3,390 flasks in 1910. No output was reported from Arizona, Oregon, Utah, or Washington in 1912. The imports for consumption were valued at $39,920 in 1912, at $251,386 in 1911, at $381 in 1910, at $8,203 in 1909, and at $8,216 in 1908. The exports were valued at $13,360 in 1912, at $13,995 in 1911, at $91,077 in 1910, at $266,243 in 1909, and at $124,960 in 1908.

Chromic iron ore.—The production (in California) of chromite in 1912 was 201 long tons, valued at $2,753, as compared with 120 long tons, valued at $1,629, in 1911, with 205 long tons, valued at $2,729, in 1910, and with 598 long tons (California and Wyoming), valued at $8,300, in 1909, with 359 long tons (California and Wyoming), valued at $7,230, in 1908, and with 290 long tons, valued at $5,640, in 1907. The imports for consumption of chrome ore in 1912 were 53,929 long tons, valued at $499,818, against 37,540 long tons, valued at $407,958, in 1911, against 38,579 long tons, valued at $415,768, in 1910, and 39,624 long tons, valued at $460,758, in 1909; the imports of chrome salts were valued at $4,461 in 1912, at $3,508 in 1911, and at $21,204 in 1910.

Molybdenum minerals.—No production of molybdenum was reported in 1908, 1909, 1910, 1911, or 1912. There was a small commercial production in 1907, as in 1906 and 1905. Imports in 1912 were valued at $4,670, at $11,409 in 1911, and at $14,402 in 1910.

Nickel.—The production of nickel in 1908, 1909, and 1910 is included under unspecified products. There was no production of nickel ore reported in 1911, but salts and metallic nickel equivalent to 445 short tons of metallic nickel, valued at about $127,000, were saved as by-products, largely from copper refineries, and about 328 short tons were saved in 1912. The imports for consumption of nickel in 1912 were valued at $5,761,967, as against $4,050,030 in 1911, $4,227,838 in 1910, and $3,036,273 in 1909; the exports in 1912 were valued at $8,515,332, as against $8,283,777 in 1911, $4,704,088 in 1910, and $4,101,976 in 1909.

Cobalt.—No cobalt was produced in the United States in 1912, 1911, or 1910. The imports for consumption were valued at $83,080 in 1912, at $59,151 in 1911, and at $6,352 in 1910.

Titanium ore.—About 275 short tons of rutile concentrates were reported from Virginia in 1912. No production of rutile was reported for 1911. A production estimated at $44,480 was reported from Virginia in 1910, against $10,000 in 1909; none was reported in 1908. There was a small output from Virginia in 1907. Imports of ferrotitanium valued at $7,631 were reported in 1912, against imports valued at $22,700 in 1911, and at $767 in 1910.

Tungsten ore.—The commercial production of concentrated tungsten ore in 1912 was 1,330 short tons, valued at $502,158, as against 1,139 short tons, valued at $407,985 in 1911, as against 1,821 short tons, valued at $832,992 in 1910, against 1,619 short tons, valued at $614,370, in 1909, and against the average annual production for the five preceding years of 956 short tons, valued at $384,309. The imports for consumption of tungsten ore in 1912 were valued at $362,422, at $85,887 in 1911, at $344,979 in 1910, and at $105,506 in 1909. Tungsten and ferrotungsten were imported valued at $323,872 in 1912 and at $143,802 in 1911.

Uranium and vanadium minerals.—There was some production of both uranium and vanadium in 1912 from Colorado and Utah. An output of vanadium from Colorado, New Mexico, and Utah, valued at about $305,500, was reported for 1911; an output was also reported for 1910 as in 1909, but no uranium. No output of either was reported for 1908. Imports for consumption of ferrovanadium valued at $2,623 were reported for 1911. Imports of uranium salts and oxide were valued at $14,357 in 1912, at $14,106 in 1911, at $10,176 in 1910, and at $12,057 in 1909.

Tantalum minerals.—No production of tantalum minerals was reported for 1912. A very small output of tantalum ore was reported as mined in 1911, as in 1910 and 1909; none seems to have been marketed in either year.

Platinum.—The production of refined platinum from domestic sources in 1912 was 1,005 ounces, valued at $45,778, as compared with 940 ounces, valued at $40,890 in 1911, with 773 ounces, valued at $25,277, in 1910, and with 638 ounces, valued at $15,950, in 1909, with 613 ounces, valued at $15,907, the average annual production for the five years ending with 1908. The average price per ounce in 1909 was $24.98, in 1910 it was $32.70, in 1911 it was $43.50, and in 1912 it was $45.55. The imports for consumption of platinum in 1912 were valued at $4,503,682, at $4,866,207 in 1911, at $3,654,664 in 1910, and at $2,973,948 in 1909.

Iridium, osmium, palladium, and rhodium.—Imports of palladium, valued at $213,397, were reported for 1912 by the Bureau of Foreign and Domestic Commerce. In 1911 imports for consumption of these metals were: Iridium, $210,616; osmium, $25,476; palladium, $56,307—a total of $292,399. In 1910 these imports were: Iridium, $140,232; osmium, $32,647; palladium, $3,570; and rhodium, $4,356—a total of $180,805. The production of these metals from domestic ores in the United States is negligible.

Antimony.—No production of antimony has been reported for several years. The imports for consumption of antimony (metal, regulus, and ore) in 1912 were valued at $859,917, at $531,011 in 1911, at $539,755 in 1910, and at $714,366 in 1909; imports of antimony salts in 1912 were valued at $81,077, at $54,426 in 1911, at $14,201 in 1910, and at $60,353 in 1909.

Bismuth.—No domestic production of bismuth was reported for 1912. The only production of bismuth of any consequence in 1909, 1910, and 1911 has been as a by-product at Grasselli, Ind., and may not be disclosed. There was a small production of bismuth in 1908; no production was reported in 1907. The imports for consumption were valued at $316,440 in 1912, at $311,771 in 1911, at $332,668 in 1910, and at $286,516 in 1909.

Tin.—About 130 short tons of stream tin, valued at $124,800, were produced on Buck Creek, Alaska, in 1912. In 1911 the output of tin ore was equivalent to 66 short tons of metallic tin, valued at $56,635, as compared with a production valued at $23,447 in 1910. The imports of tin for consumption in 1912 were valued at $50,768,955, as against $43,584,219 in 1911 and $33,926,136 in 1910.

Cadmium.—Cadmium was produced by the Grasselli Chemical Co., of Cleveland, Ohio, in 1906. There was a production also in 1907, 1908, 1909, and 1910; in 1911 and 1912 there were two producers. The imports of cadmium for consumption were valued at $3,764 in 1912, at $3,870 in 1911, at $2,295 in 1910, $4,559 in 1909, $2,390 in 1908, $1,633 in 1907, and $10,522 in 1906.

Selenium and tellurium.—There was a small output of selenium in 1912, as in 1911, 1910, and 1909. Selenium is recovered in the anode mud or slime of the electrolytic copper refineries, particularly at Baltimore, Md., and at Perth Amboy and Chrome, N. J. Tellurium is found combined in large quantities with gold and silver at Cripple Creek, Colo., in smaller quantities at other mining camps of the West, and also in the mud or slime of electrolytic copper refineries.

FUELS.

Coal.—In 1906 the production of coal in the United States exceeded 400,000,000 short tons; in 1910, four years later, it exceeded half a billion tons, but fell a little short of this maximum in 1911; in 1912 it exceeded this quantity by over 34,000,000 tons. The output in 1912 was 534,466,580 short tons, valued at $695,606,071, against 496,371,126 short tons, valued at $626,565,211, in 1911, against 501,596,378 short tons, valued at $629,557,021, in 1910, and against 432,780,130 short tons, valued at $538,279,696, the average production for the five-year period from 1905 to 1909. Of this total, the output of anthracite coal in 1912 was 75,322,855 long tons, valued at $177,622,626, as compared with 80,771,488 long tons, valued at $175,189,392, in 1911, and with 75,433,246 long tons, valued at $160,275,302, in 1910, an increase in value in 1912 as compared with 1911 of $2,433,234. The average price of the anthracite coal actually sold during the season of 1912 at the mine was $2.36 per long ton, against $2.17 in 1911, $2.12 in 1910, and $2.06 in 1909.

The output of bituminous coal (which includes semianthracite and all semibituminous and lignite coals) amounted in 1912 to 450,104,982 short tons, valued at $517,983,445, as compared with 405,907,059 short tons, valued at $451,375,819, in 1911, and with 417,111,142 short tons, valued at $469,281,719, in 1910. The increase in the production of bituminous coal in 1912 from 1911 was, therefore, 44,197,923 short tons, or 10.89 per cent, in quantity and $66,607,626, or 14.76 per cent, in value. The average price of bituminous coal per ton at the mines was $1.15 in 1912, against $1.11 in 1911, and against $1.12 in 1910.

The imports for consumption of anthracite were valued at $8,329 in 1912, at $12,550 in 1911, and at $42,244 in 1910; the imports of bituminous were valued at $4,509,066 in 1912, at $3,604,797 in 1911, at $4,761,223 in 1910, at $3,628,533 in 1909, and $3,964,843 in 1908. The exports were in 1912: Anthracite, $19,425,263; bituminous, $36,817,633; in 1911, anthracite, $18,093,285; bituminous, $34,499,989; in 1910, anthracite, $14,785,387; bituminous, $26,685,405.

Coal briquets.—The production of coal briquets in the United States in 1912 was 220,064 short tons, valued at $952,261, as compared with 218,443 short tons, valued at $808,721, in 1911, and with 139,661 short tons, valued at $452,697, in 1909. The production was not reported in 1910.

Coke.—The production of coke in 1912 amounted to 43,983,599 short tons (11,115,164 tons from retort ovens), valued at $111,736,696, as against 35,551,489 short tons (7,847,845 tons from retort ovens), valued at $84,130,849, in 1911, as against 41,708,810 short tons (7,138,734 tons from retort ovens), valued at $99,742,701, in 1910, against 39,315,065 short tons (6,254,644 tons from retort ovens), valued at $89,065,483, in 1909; and against 31,821,307 short tons, valued at $72,850,456, the average for the five years from 1904 to 1908, inclusive.

The average price per ton in 1912 was $2.54, against $2.37 in 1911, against $2.39 in 1910, against $2.29 in 1909, $2.40 in 1908, and $2.74 in 1907. The average output from the by-product ovens was 2,133 tons per oven in 1912, 1,817 short tons per oven in 1911, 1,762 short tons per oven in 1910, and 1,598 tons per oven in 1909. The average output from beehive ovens in 1912 was 484 short tons per oven, against 468 tons per oven in 1911, against 376 tons per oven in 1910, and 361 short tons per oven in 1909. The imports for consumption of coke were valued at $488,398 in 1912, at $254,455 in 1911, at $625,130 in 1910, and at $736,120 in 1909. The exports were valued at $3,002,742 in 1912, at $3,215,990 in 1911, at $3,053,293 in 1910, and at $3,232,673 in 1909.

Natural gas.—The value of natural gas produced in 1912 was $84,563,957, as compared with $74,621,534 in 1911, with $70,756,158 in 1910, with $63,206,941 in 1909, and with $47,199,264, the average annual value for the preceding five-year period. No imports of natural gas were reported for 1912, 1911, and 1910, as against $6,060 in 1909, and $22,003 in 1908.

Petroleum.—The total production of crude petroleum in 1912 was 222,113,218 barrels, valued at $163,802,334, as against 220,449,391 barrels, valued at $134,044,752, in 1911, against 209,557,248 barrels, valued at $127,899,688, in 1910, and against 179,801,018 barrels, valued at $110,809,311, the average annual production for the years 1905 to 1909. The average price for crude petroleum per barrel in 1912 was 73.7 cents, against 60.8 cents in 1911, and 61 cents in 1910. The imports for consumption of petroleum in 1912 were valued at $6,082,881, as against $2,410,884 in 1911, and $1,398,861 in 1910. The exports in 1912 were valued at $124,210,382, against $105,922,848 in 1911, and against $94,107,022 in 1910.

The imports for consumption of ozokerite and paraffin in 1912 were valued at $1,018,524, against $792,818 in 1911, and against $1,025,829 in 1910. The exports of paraffin and paraffin wax were valued at $9,602,758 in 1912, against $7,047,856 in 1911, $7,329,143 in 1910,

$7,608,624 in 1909, and against an average annual value of $8,348,043 for the years from 1904 to 1908, inclusive.

Peat.—The commercial production of peat in 1912, chiefly in the form of peat fertilizer filler and peat food for stock, was valued at $228,572, against $272,114 in 1911, and $140,209 in 1910. The imports of peat-moss litter have averaged about $40,000 for the last seven years.

STRUCTURAL MATERIALS.

Cement.—The total production of hydraulic cement in the United States was 83,351,191 barrels, valued at $67,461,513, in 1912, as compared with 79,547,958 barrels, valued at $66,705,136, in 1911, with 77,785,141 barrels, valued at $68,752,092, in 1910, with 66,689,715 barrels, valued at $53,610,563, in 1909, and with 45,583,855 barrels, valued at $43,529,447, the annual average production for the years 1904 to 1908. The Portland cement production in 1912 was 82,438,096 barrels, valued at $67,016,928, as compared with 78,528,637 barrels, valued at $66,248,817, in 1911, and with 76,549,951 barrels, valued at $68,205,800, in 1910. The production of natural cement in 1912 was 821,231 barrels, valued at $367,222, as compared with 926,091 barrels, valued at $378,533, in 1911, and with 1,139,239 barrels, valued at $483,006, in 1910. The production of puzzolan cement in 1912 amounted to 91,864 barrels, valued at $77,363, as against 93,230 barrels, valued at $77,786, in 1911, and 95,951 barrels, valued at $63,286, in 1910. The imports for consumption of hydraulic cement in 1912 were valued at $93,558, as compared with $242,722 in 1911 and with $395,526 in 1910. The exports were valued at $6,160,341 in 1912, at $4,632,215 in 1911, and at $3,477,981 in 1910.

Clay products.—The value of all clay products in 1912, as reported to the survey, was $172,811,275, as compared with $162,236,181 in 1911, with $170,115,974 in 1910, and with $153,838,171, the average annual value for the five preceding years. The pottery products were valued at $36,504,164 in 1912, at $34,518,560 in 1911, and at $33,784,678 in 1910. The imports for consumption of pottery in 1912 amounted to $9,555,530, as against $10,638,616 in 1911, and $11,131,158 in 1910. The imports of brick in 1912 were valued at $166,322, against $166,133 in 1911, and $222,183 in 1910. The exports of brick in 1912 were valued at $3,823,111, at $2,264,354 in 1911, and at $1,602,913 in 1910, and the exports of pottery at $1,177,784 in 1912, at $1,401,366 in 1911, and at $1,041,689 in 1910. The imports of kaolin or china clay in 1912 were valued at $1,629,105, at $1,461,068 in 1911, and at $1,593,472 in 1910. The imports of other clays amounted to $323,131 in 1912, against $235,254 in 1911, and $320,891 in 1910.

Glass sand.—The production of glass sand in 1912 was 1,465,386 short tons, valued at $1,430,471, as compared with $1,538,666 short tons, valued at $1,543,733, in 1911, with 1,461,089 short tons, valued at $1,516,711, in 1910, and with $1,172,912, the average annual value for the period from 1905 to 1909.

Gypsum.—The output of crude gypsum in 1912 was 2,500,757 short tons, valued in its first marketable condition at $6,563,908, as compared with 2,323,970 short tons, valued at $6,462,035, in 1911, with 2,379,057 short tons, valued at $6,523,029, in 1910, and with an annual average value of $4,358,406 for the five years from 1905 to 1909.

The greatly increased production of late years is attributable to the largely increased use of wall plaster and of plaster of Paris in large modern buildings. The imports for consumption in 1912 were valued at $488,481, at $450,806 in 1911, at $502,111 in 1910, and at $425,137 in 1909.

Lime.—The production of lime in 1912 was 3,529,462 short tons, valued at $13,970,114, against 3,392,915 short tons, valued at $13,689,054, in 1911, against 3,505,954 short tons, valued at $14,088,039, in 1910, and against $12,203,259, the average annual value for the years 1905 to 1909. The average price per short ton was $3.96 in 1912, $4.03 in 1911, and $4.02 in 1910. The imports for consumption in 1912 were 4,268 short tons, valued at $48,153, against 5,232 short tons, valued at $55,255 in 1911, and against 6,498 short tons, valued at $63,791 in 1910. The exports reported in 1912 were valued at $199,515, at $153,212 in 1911, and at $127,952 in 1910.

Sand and gravel.—The production of sand for molding, building, engine, furnace, and other uses and of gravel reported in 1912 was 66,889,175 short tons, valued at $21,682,737, against 65,308,293 short tons, valued at $19,614,850, in 1911, and 67,949,347 short tons, valued at $19,520,919, in 1910. The imports for consumption of sand in 1912 were valued at $141,690, at $147,268 in 1911, and at $133,757 in 1910.

Sand-lime brick.—The production of sand-lime brick in 1912 was valued at $1,200,223, at $897,664 in 1911, at $1,169,153 in 1910, and at $1,109,625, the average value for the five-year period from 1905 to 1909.

Slate.—The production of slate in 1912 was valued at $6,043,318, against $5,728,019 in 1911, against $6,236,759 in 1910, and against $5,792,402, the average annual value for the period 1905 to 1909. The imports of slate in 1912 were valued at $14,768, at $8,367 in 1911, and at $4,127 in 1910. The exports of roofing slate were not reported separately in 1912, 1911, or 1910; in 1909 they were valued at $209,383, and at $197,216 in 1908.

Stone.—The value of all kinds of stone produced in the United States in 1912 amounted to $78,284,572, as compared with $77,108,567 in 1911, with $76,520,584 in 1910; the annual average value for the period 1905 to 1909 was $67,868,209. The imports for consumption of marble and stone were valued in 1912 at $1,662,231, against $1,556,398 in 1911, and against $1,569,143 in 1910; the exports were valued at $1,839,878 in 1912, against $1,810,182 in 1911, and against $1,538,339 in 1910.

Included under stone is the limestone used for fluxing in blast furnaces, which in 1912 was 20,190,554 long tons, valued at $9,937,772, as compared with 16,126,650 long tons, valued at $7,987,208, in 1911, with 18,203,882 long tons, valued at $9,345,733, in 1910, with 15,772,863 long tons, valued at $7,921,807, in 1909, and with an average production of 14,066,574 long tons, valued at $6,873,891, for the years from 1904 to 1908.

ABRASIVE MATERIALS.

Artificial abrasives.—The total production of the artificial abrasives—alundum, carborundum, and crushed steel—in 1912 amounted to 29,002,000 pounds, valued at $1,747,120, against 21,292,000 pounds,

valued at $1,493,040, in 1911, and against 23,027,000 pounds, valued at $1,604,030, in 1910.

Corundum and emery.—No domestic corundum was reported in 1909, 1910, 1911, or 1912. The output of emery was 992 short tons, valued at $6,652, against 659 short tons, valued at $6,778, in 1911, against 1,028 short tons, valued at $15,077, in 1910, and against an average annual value of the combined production of corundum and emery for the five years ending in 1909 of $28,999. The imports for consumption were valued at $501,725 in 1912, at $336,644 in 1911, at $629,758 in 1910, and at $338,997 in 1909.

Garnet.—The production of abrasive garnet during 1912 amounted to 4,182 short tons, valued at $137,800, against 4,076 short tons, valued at $121,748, in 1911, against 3,814 short tons, valued at $113,574, in 1910, and against $136,742, the annual average value for the years 1905 to 1909.

Grindstones.—The total value of all kinds of grindstones and pulp stones produced in 1912 was $916,339, against $907,316 in 1911, against $796,294 in 1910, and against $751,734, the average annual value for the period 1905 to 1909. The imports were valued at $131,080 in 1912, at $123,727 in 1911, at $106,596 in 1910, and at $99,153 in 1909.

Infusorial earth and tripoli.—The value of the infusorial earth and tripoli production in 1912 was $125,446, against $147,462 in 1911, against $130,006 in 1910, and against $92,068, the average annual value for the years 1905 to 1909. The imports for consumption of rotten stone and tripoli were valued at $24,253 in 1912, at $35,665 in 1911, at $56,657 in 1910, and at $24,024 in 1909.

Millstones and burrstones.—The value of the production of millstones and burrstones in 1912 was $71,414, against $40,069 in 1911, against $28,217 in 1910, against $35,393 in 1909, and against $37,413, the annual average for the five preceding years. The imports for consumption were valued at $27,562 in 1912, at $36,028 in 1911, at $34,763 in 1910, and at $22,590 in 1909.

Oilstones and whetstones.—The production of oilstones and whetstones in 1912 was valued at $232,218, against $214,991 in 1911, against $228,694 in 1910, $214,019 in 1909, and against the average annual value of $236,615 for the five years 1904 to 1908. The imports for consumption were valued at $45,398 in 1912, at $54,379 in 1911, at $45,819 in 1910, and at $68,018 in 1909.

Pumice.—The production of pumice amounted to 27,146 short tons, valued at $86,687, in 1912, against 21,689 short tons, valued at $88,399, in 1911, against 23,271 short tons, valued at $94,943, in 1910, and against 15,103 short tons, valued at $33,439, in 1909. The imports for consumption were valued at $74,478 in 1912, at $118,977 in 1911, at $104,425 in 1910, and at $100,997 in 1909.

CHEMICAL MATERIALS.

Arsenious oxide.—The domestic production of arsenious oxide (white arsenic) in 1912 amounted to 6,282,000 pounds, valued at $190,757, against 6,264,000 pounds, valued at $73,408, in 1911, against 2,994,000 pounds, valued at $52,305, in 1910. The imports for con-

sumption of white arsenic, metallic arsenic, and arsenic sulphide in 1912 were valued at $428,741, at $247,323 in 1911, and at $314,306 in 1910.

Borax.—The reported returns for 1912 gave an aggregate production of crude borax of 42,315 short tons, valued at $1,127,813, against 53,330 short tons, valued at $1,569,151, in 1911, against 42,357 short tons, valued at $1,201,842, in 1910, and against $1,166,489, the average annual value from 1905 to 1909. The imports for consumption of borax in 1912 were valued at $11,249, at $23,628 in 1911, and at $12,400 in 1910.

Bromine.—The production of bromine in 1912 amounted to 647,200 pounds, valued at $136,174, as compared with 651,541 pounds, valued at $110,902, in 1911, and with 245,437 pounds, valued at $31,684, in 1910.

Calcium chloride.—The production of calcium chloride in 1912 was 18,550 short tons, valued at $117,272, against 14,606 tons, valued at $91,215, in 1911, and against 10.971 tons, valued at $74,713, in 1910.

Fluorspar and cryolite.—The commercial production of fluorspar in 1912 was 116,545 short tons, valued at $769,163, as compared with 87,048 short tons, valued at $611,447, in 1911, with 69,427 short tons, valued at $430,196, in 1910, and with 47,439 short tons, valued at $282,320, the average production for the years 1905 to 1909. The imports for consumption in 1909 were 6,971 short tons, valued at $26,377; in 1910 they were 42,488 short tons, valued at $135,152; in 1911 they were 32,764 short tons, valued at $80,592; and in 1912 they were 26,176 short tons, valued at $71,616. The imports of cryolite in 1912 were valued at $48,293, at $47,093 in 1911, and at $2,343 in 1910.

Lithium minerals.—No production of lithium minerals was reported in 1911 or 1912; the production in 1910 was small, as in 1909, and the figures may not be published.

Phosphate rock.—The total commercial marketed production of phosphate rock reported to the Survey in 1912 amounted to 2,973,332 long tons, valued at $11,675,774, as compared with 3,053,279 long tons, valued at $11,900,693, in 1911, with 2,654,988 long tons, valued at $10,917,000, in 1910, and with $9,638,396, the average annual value for the years 1905 to 1909. The total quantity of phosphate rock reported as mined during 1912 was 3,190,587 long tons, as against 3,102,415 long tons mined in 1911. The imports for consumption of crude phosphate, guano, kainite, manure salts, etc., in 1912 were valued at $8,893,090, at $10,387,588 in 1911, and at $10,762,472 in 1910. The exports of phosphate rock in 1912 were 1,206,520 long tons, valued at $8,996,456, against 1,246,577 long tons, valued at $9,235,388, in 1911, and against 1,083,037 long tons, valued at $8,234,276, in 1910.

Potash salts.—There was no actual production of potash salts in the United States in 1912. Search for potash salts was carried on by the United States Geological Survey by deep drilling for saline residues, by the collection and examination of natural and artificial brines and bitterns, by the examination of deposits of alunite and other minerals containing potassium, and the examination of certain occurrences of igneous rocks known to contain large quantities of potash. Besides the work of the Survey, the systematic study of the seaweeds or kelps of the Pacific coast as a source of potash has been

continued by the Bureau of Soils of the Department of Agriculture, which has also undertaken a field survey of the desert basins of the arid States of the West in search for fertilizer materials. The imports of potash salts in 1912 were valued at $10,692,285 and at $11,783,381 in 1911.

Salt.—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda, and other sodium salts. The domestic production of salt in 1912 amounted to 33,324,808 barrels of 280 pounds, valued at $9,402,772, as compared with 31,183,968 barrels, valued at $8,345,692, in 1911, with 30,305,656 barrels, valued at $7,900,344, in 1910, and with $7,252,012, the value of the average annual output 1905 to 1909. The imports for consumption in 1912 were valued at $370,648, at $375,030 in 1911, and at $370,922 in 1910. The exports in 1912 were valued at $418,525, at $335,285 in 1911, and at $320,926 in 1910.

Sodium nitrate.—The imports of sodium nitrate for consumption in manufacture of fertilizers and other chemical products amounted in value in 1912 to $16,544,511, as compared with $16,814,268 in 1911, and with $16,601,343 in 1910.

Sulphur and pyrite.—The domestic production of sulphur in 1912 was 303,472 long tons, valued at $5,256,422, against 265,664 long tons, valued at $4,787,049, in 1911, against 255,534 long tons, valued at $4,605,112, in 1910, and against 275,538 long tons, valued at $5,009,274, the average annual production for the years 1905 to 1909. The production of pyrite in 1912 was 350,928 long tons, valued at $1,334,259, against 301,458 long tons, valued at $1,164,871, in 1911, against 241,612 long tons, valued at $977,978, in 1910, and against 246,295 long tons, valued at $910,003, the average annual production for the five years 1905 to 1909. The imports for consumption of sulphur fell in value from $558,611 in 1910 to $552,836 in 1911, and rose to $583,974 in 1912. The exports in 1912 amounted to 57,736 long tons, valued at $1,076,414, against 28,103 long tons, valued at $545,420, in 1911, against 30,742 long tons, valued at $552,941, in 1910. The imports for consumption of pyrite were valued at $3,841,683 in 1912, at $3,788,803 in 1911, at $2,748,647 in 1910, and at $2,428,580 in 1909.

Sulphuric acid from copper and zinc smelters.—The production of sulphuric acid from the fumes of copper and zinc smelters was reported for the first time in 1911. It amounted to 438,300 short tons (60° Baumé), valued at $2,733,696, in 1911, and to 614,073 short tons (60° Baumé), valued at $4,240,941, in 1912.

PIGMENTS.

Barytes.—The production of crude barytes in 1912 was 37,478 short tons, valued at $153,313, as compared with 38,445 short tons, valued at $122,792, in 1911, with 42,975 short tons, valued at $121,746, in 1910, with 61,945 short tons, valued at $209,737, in 1909, and with 58,468 short tons, valued at $179,269, the average annual production for the five years from 1904 to 1908. The imports for consumption of barytes were valued at $79,315 in 1912, at $58,726 in 1911, and at $78,239 in 1910. The imports of barium compounds were valued at $376,017 in 1912, at $398,213 in 1911, and at $470,449 in 1910.

Cobalt oxide.—The production of cobalt oxide in 1908 and 1909 is included under unspecified products. No production was reported for 1910, 1911, or 1912. A production was reported from Oregon and Missouri in 1907. No production was reported in 1905 and 1906. The imports for consumption in 1912 were valued at $83,080, at $59,151 in 1911, and at $6,352 in 1910.

Mineral paints.—The commercial production of mineral paints in 1912 amounted to 181,154 short tons, valued at $10,069,588 (zinc oxide included), as compared with 143,350 short tons, valued at $7,842,583 (zinc oxide included), in 1911, as compared with the production (zinc oxide being excluded) of 85,685 short tons, valued at $2,174,735, in 1910; with 78,771 short tons, valued at $2,373,805, in 1909; with 69,244 short tons, valued at $2,367,723, in 1908; and with 75,566 short tons, valued at $2,984,935, in 1907. Imports for consumption of ocher in 1912 were valued at $148,306; in 1911, $110,932; of sienna in 1912, $45,794; in 1911, $37,219; of umber in 1912, $31,626; in 1911, $22,115.

Zinc oxide.—The production of zinc oxide in 1911 and 1912 may not be separately reported; it amounted to 58,481 short tons, valued at $5,238,945, in 1910, as compared with 68,974 short tons, valued at $6,156,755, in 1909, and with 66,944 short tons, valued at $5,578,243, the average production for the years 1904 to 1908. The imports for consumption of zinc oxide in 1912 were valued at $386,153, at $357,466 in 1911, and at $396,573 in 1910. The exports were valued in 1912 at $1,247,702, at $1,051,311 in 1911, and at $943,968 in 1910.

MISCELLANEOUS.

Asbestos.—The asbestos commercially produced in the United States in 1912 was obtained from deposits in Vermont, Georgia, and Wyoming; in 1911 Virginia also had a production. The total commercial production in 1912 was 4,403 short tons, valued at $87,959, as against 7,604 short tons, valued at $119,935, in 1911, against 3,693 short tons, valued at $68,357, in 1910, and against 1,896 short tons, valued at $33,133, the annual average production for 1905 to 1909. The imports for consumption were valued at $1,819,771 in 1912, at $1,703,639 in 1911, and at $1,543,248 in 1910.

Asphalt.—Under this title are included the various bitumens or hydrocarbons not discussed elsewhere under the heading "Petroleum." The commercial production in 1912 was 449,510 short tons, valued at $4,620,731, as compared with 364,266 short tons, valued at $3,991,109, in 1911, with 260,080 short tons, valued at $3,080,067, in 1910, and with 180,845 short tons, valued at $1,812,227, the average production for the five preceding years. The imports of asphalt were valued in 1912 at $921,145, in 1911 at $789,236, at $785,963 in 1910, and at $633,205 in 1909. The exports for 1912 were valued at $1,170,882 and at $868,552 in 1911.

Feldspar.—The production of feldspar in 1912 was 86,572 short tons, valued at $520,562, against 92,700 short tons, valued at $579,008, in 1911, against 81,102 short tons, valued at $502,452, in 1910, and against 76,539 short tons, valued at $424,602, in 1909.

Fertilizers.—Fertilizers, including apatite, bone dust, guano, kainite, kierserite, crude phosphates, and other manures, are reported under phosphate rock and under potash salts.

Fuller's earth.—As reported to the Survey, the production of fuller's earth in 1912 was 32,715 short tons, valued at $305,522; 40,697 short tons, valued at $383,124, in 1911, against 32,822 short tons, valued at $293,709, in 1910, and against an average annual production for the years 1905 to 1909 of 30,654 short tons, valued at $270,328. The imports for consumption were valued at $145,337 in 1912, at $143,594 in 1911, and at $132,545 in 1910.

Gems and precious stones.—The value of gems and precious stones found in the United States in 1912 was reported at $319,722, as against $343,692 in 1911, against $295,797 in 1910, and $534,380 in 1909. Pearls produced in 1907 were valued at $264,500, as against $381,000 in 1906. No production of pearls was reported for 1908, 1909, 1910, 1911, or 1912. Imports of precious stones in 1912 were valued at $41,363,325, as against $40,820,436 in 1911, against $40,704,487 in 1910, against $40,237,509 in 1909, and against an annual average value of $30,648,792 for the years 1904 to 1908.

Graphite.—The commercial production of crystalline graphite during 1912 amounted to 3,543,771 pounds, valued at $187,689, as compared with 4,790,000 pounds, valued at $256,050, in 1911; with 5,590,592 pounds, valued at $295,733, in 1910; and with $218,579, the average annual value for the period from 1905 to 1909. The production of amorphous graphite in 1912 was 923 short tons, valued at $24,344, as compared with 1,223 short tons, valued at $32,415, in 1911; with 1,407 short tons, valued at $39,710, in 1910, and with $83,225, the average value for the period from 1905 to 1909. The production of manufactured graphite in 1912 was 12,896,347 pounds, valued at $830,193, the average price being 6.44 cents per pound, as compared with 10,144,000 pounds, valued at $664,000, the average price being 6.55 cents per pound in 1911; with 13,149,100 pounds, valued at $945,000, the average price being 7.2 cents per pound, in 1910. The average annual value for the five years, 1905–1909, was $421,018. The imports for consumption of graphite in 1912 were valued at $1,709,337, against $1,495,729 in 1911, against $1,872,592 in 1910, $1,854,459 in 1909, and $762,367 in 1908.

Magnesite.—The production of crude magnesite continues to be limited to California. During 1912 the commercial production was 10,512 short tons, valued at $105,120, against 9,375 short tons, valued at $75,000, against 12,443 short tons, valued at $74,658, in 1910, and against 7,070 short tons, valued at $23,782, the average for 1905 to 1909. The imports for consumption of magnesite and magnesia in 1912 were valued at $1,430,457, against $1,224,987 in 1911, and against $1,578,683 in 1910.

Mica.—The total production of mica in 1912 was 845,483 pounds of sheet mica, valued at $282,823, and 3,226 short tons of scrap mica, valued at $49,073, against 1,887,201 pounds of sheet mica, valued at $310,254, and 3,512 short tons of scrap mica, valued at $45,550, in 1911, against 2,476,190 pounds of sheet mica, valued at $283,832, and 4,065 short tons of scrap mica, valued at $53,265, in 1910, and against annual values for the years 1905 to 1909 of $246,159 for sheet mica and of $32,669 for scrap mica. The imports for consumption of mica in 1912 were valued at $748,973, against $502,163 in 1911, and against $724,525 in 1910.

Mineral waters.—The total production of mineral waters in 1912 was 62,281,201 gallons, valued at $6,615,671, as compared with

63,788,552 gallons, valued at $6,837,888, in 1911, with 62,030,125 gallons, valued at $6,357,590, in 1910, with 64,674,486 gallons, valued at $6,894,134, in 1909; and with the average production of 48,910,285 gallons, valued at $6,956,539, for the years 1904 to 1908. The imports for consumption of mineral waters in 1912 were valued at $930,091, at $1,037,485 in 1911, and at $983,136 in 1910.

Monazite and zircon.—There was no production of monazite or zircon in the United States during 1912. Monazite is the principal source of the thorium oxide used in the manufacture of mantles for incandescent gas lights, such as the Welsbach lamp. Zircon has been a source of zirconia used chiefly in the manufacture of certain electric glower lights, such as the Nernst lamp.

The domestic supply of monazite has come from the western part of the Piedmont region of North Carolina and South Carolina, where it occurs in the form of sand in the stream gravels over an area of some 3,500 square miles. The occurrence of monazite is known in other parts of these States and of the United States, but these localities have not contributed to the production. The output of zircon for commercial purposes has come from Henderson County, N. C., where it has been found in several deposits associated with pegmatite.

The production of monazite declined from a maximum of 1,352,418 pounds, valued at $163,908, in 1905, to 99,301 pounds, valued at $12,006, in 1910. There has been no production during 1911 and 1912, and the gas-mantle industry of the United States has been supplied by imports of monazite from Brazil and of manufactured thorium salts from Germany.

A small amount of washing was done at a few of the Carolina mines to fill the conditions of the leases, but no shipments of monazite were made.

The imports for consumption of thorium nitrate in 1912 were 117,485 pounds, valued at $225,386, against 121,111 pounds, valued at $238,841, in 1911; against 124,808 pounds, valued at $219,615, in 1910; 127,833 pounds, valued at $236,057, in 1909; and 65,289 pounds, valued at $173,239, in 1908. The imports of monazite and thorium oxide in 1912 were valued at $47,334, against $60,542 in 1911, against $48,199 in 1910, and $27,920 in 1909.

The production of zircon has always been irregular in the United States, but has been smaller in the last several years than before. From a production of 26 tons in 1883 the production has declined to a few thousand pounds each year, and to nothing in 1912.

Quartz.—The production of quartz in 1912 was 97,874 short tons, valued at $191,685, as compared with 87,943 short tons, valued at $155,122, in 1911; with 63,577 short tons, valued at $193,757, in 1910; as compared with 135,469 short tons, valued at $249,466, in 1909; with 47,316 short tons, valued at $190,157, in 1908; and with 33,192 short tons, valued at $223,801, in 1907. The value of the unground flint stones imported for consumption in 1912 was $292,052, against $236,158 in 1911, against $307,286 in 1910, $301,547 in 1909, and $219,754 in 1908.

Talc and soapstone.—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of talc and soapstone in 1912 amounted to 92,403 short tons, valued at $1,050,693, as compared with 81,521 short tons, valued at $1,032,732, in 1911; with 79,006 short

tons, valued at $864,213, in 1910; and with 60,086 short tons, valued at $796,460, the average annual production for the five-year period from 1905 to 1909. The imports for consumption of talc in 1912 were valued at $122,956, at $88,050 in 1911, at $106,460 in 1910, and at $56,287 in 1909.

Fibrous talc.—This variety of talc or soapstone occurs in but one locality in the United States—Gouverneur, St. Lawrence County, N. Y. It is used principally as makeweight in the manufacture of paper. In 1912 the production was 66,867 short tons, valued at $656,270, as against 62,030 short tons, valued at $613,286, in 1911; against 71,710 short tons, valued at $728,180, in 1910; and against 61,049 short tons, valued at $537,109, the average annual production for the years 1905–1909.

MINERAL PRODUCTS OF THE UNITED STATES, IN 1911 AND 1912, BY SUBSTANCES.

From the following tabular statement headed "Mineral products of the United States in 1911 and 1912," all unnecessary duplication has been excluded. The manufactured coke product, amounting in 1912 to 43,893,599 short tons, and valued at $111,736,696, is excluded, as the quantity and value of the coal used in its manufacture are included in the statistics of coal production. Similarly, white lead, red lead, lithopone, Venetian red, litharge, and orange mineral, whose average aggregate value for the last 10 years has largely exceeded $15,000,000, are not given in the table, the base from which they are made being included in the output of pig lead. Zinc white or zinc oxide, zinc-lead, sublimed blue lead, and sublimed white lead, on the other hand, made directly from the ores, and consequently not included in zinc or lead production, are tabulated. The production of pig iron and its value are given in the table as the best means of presenting the statistics of the production of iron in the first marketable condition, the value of iron ores being excluded. Similarly, the value of the products of the clay industries is given as being the first marketable condition of the greater part of the clay produced, although the production and value of the clay mined and sold in the raw state by clay miners to manufacturers of clay are elsewhere shown separately, but are not included in the tabular statement, in order to avoid duplication.

The figures for gold and silver for 1911 and 1912 are the official figures agreed upon by the United States Geological Survey and the Director of the Mint.

Mineral products of the United States in 1911 and 1912.

	Product.	1911		1912		Increase (+) or decrease (−) in 1912.		Percentage of increase (+) or decrease (−) in 1912.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	METALS.								
1	Pig iron [a] (spot value [b]), long tons (2,240 lbs.)	23,257,288	$327,334,624	30,180,969	$420,563,388	+ 6,923,681	+$93,228,764	+29.77	+ 28.48
2	Ferro-alloys [c] long tons (2,240 lbs.)	253,375	8,377,832	328,685	12,223,776	+ 75,310	+ 3,845,944	+29.72	+ 45.91
3	Silver, commercial value [d] troy ounces	60,399,400	32,615,700	63,766,800	39,197,500	+ 3,367,400	+ 6,581,800	+ 3.50	+ 20.19
4	Gold, coining value [e] do	4,687,053	96,890,000	4,520,717	93,451,500	− 166,336	− 3,438,500	− 3.50	− 3.50
5	Copper [f], value at New York City, pounds	1,097,232,749	137,154,092	1,243,268,720	205,139,338	+146,035,971	+ 67,985,246	+13.30	+ 49.57
6	Lead [f], value at New York City, short tons (2,000 lbs.)	405,863	36,527,670	415,395	37,385,550	+ 9,532	+ 858,380	+ 2.35	+ 2.35
7	Zinc [f], value at St. Louis short tons	271,621	30,964,794	323,907	44,699,166	+ 52,286	+ 13,734,372	+19.20	+ 44.40
8	Quicksilver, value at San Francisco, flasks (75 lbs. net)	21,256	977,989	25,064	1,053,941	+ 3,808	+ 75,952	+17.91	+ 7.77
9	Aluminum (consumption) pounds	46,125,000	8,084,000	65,607,000	11,907,000	+ 19,482,000	+ 3,823,000	+42.28	+ 47.29
10	Antimony [g] short tons								
11	Antimonial lead do	14,078	1,380,556	13,552	1,311,348	− 526	− 69,208	− 3.88	− 5.28
12	Nickel [h], value at New York City, pounds	890,000	127,000						
13	Tin pounds		56,635		124,800		+ 68,165		+120.35
14	Platinum, value at New York City, troy ounces	940	40,890	1,005	45,778	+ 65	+ 4,888	+ 6.91	+ 11.95
15	Total value of metals		680,531,782		867,103,085		+186,571,303		+ 27.42
	NONMETALS (spot value).								
16	Bituminous coal [i] short tons	405,907,059	451,375,819	450,104,982	517,983,445	+44,197,923	+ 66,607,626	+ 10.89	+ 14.76
17	Pennsylvania anthracite long tons	80,771,488	175,189,392	75,322,855	177,622,626	− 5,448,633	+ 2,433,234	− 6.75	+ 1.39
18	Natural gas		74,621,534		84,563,957		+ 9,942,423		+ 13.32
19	Petroleum barrels (42 gals.)	220,449,391	134,044,752	222,113,218	163,802,334	+ 1,663,827	+ 29,757,582	+ .75	+ 22.20
20	Peat		272,114		228,572		− 43,542		− 19.04
21	Clay products [j]		162,236,181		172,811,275		+ 10,575,094		+ 6.52
22	Cement barrels (380 lbs. net)	79,547,958	66,705,136	83,351,191	67,461,513	+ 3,803,233	+ 756,377	+ 4.78	+ 1.13
23	Glass sand short tons	1,538,666	1,543,733	1,465,386	1,430,471	− 73,280	− 113,262	− 4.76	− 7.34
24	Gypsum do	2,323,970	6,462,035	2,500,757	6,563,908	+ 176,787	+ 101,873	+ 7.60	+ 1.58
25	Lime do	3,392,915	13,689,054	3,529,462	13,970,114	+ 136,547	+ 281,060	+ 4.00	+ 2.05
26	Sand (molding, building, etc.) and gravel, short tons	65,308,273	19,614,850	66,889,175	21,682,737	+ 1,580,902	+ 2,067,887	+ 2.42	+ 10.54
27	Sand-lime brick		897,664		1,200,223		+ 302,559		+ 33.71
28	Slate		5,728,019		6,043,318		+ 315,299		+ 5.50
29	Stone [k]		77,108,567		78,284,572		+ 1,176,005		1.53

30	Corundum and emery.....short tons..	659	6,778	992	6,652	+ 333	− 126	+ 50.53	− 1.86
31	Abrasive quartz and feldspar.....do....		(l)	(l)	(l)				
32	Garnet, abrasive.....do....	4,076	121,748	4,182	137,800	+ 106	+ 16,052	+ 2.60	+ 13.18
33	Grindstones.....		907,316		916,339		+ 9,023		+ .99
34	Infusorial earth and tripoli.....short tons..		147,462		125,446		− 22,016		− 14.93
35	Millstones.....		40,069		71,414		+ 31,345		+ 43.89
36	Oilstones, etc.....		214,991		232,218		+ 17,227		+ 8.01
37	Pumice.....short tons..	21,689	88,399	27,146	86,687	+ 5,457	− 1,712	+ 25.16	− 1.94
38	Arsenious oxide.....pounds..	6,264,000	73,408	6,282,000	190,757	+ 18,000	+ 117,349	+ .29	+159.86
39	Borax, crude.....short tons..	53,330	1,569,151	42,315	1,127,813	− 11,015	− 441,338	− 20.65	− 28.10
40	Bromine.....pounds..	651,541	110,902	647,200	136,174	− 4,341	+ 25,272	− .67	+ 22.79
41	Calcium chloride.....short tons..	14,606	91,215	18,550	117,272	+ 3,944	+ 26,057	+ 27.00	+ 28.57
42	Fluorspar.....do....	87,048	611,447	116,545	769,163	+ 29,497	+ 157,716	+ 33.89	+ 25.79
43	Lithium minerals.....do....								
44	Marls.....do....								
45	Phosphate rock.....long tons..	3,053,279	11,900,693	2,973,332	11,675,774	− 79,947	− 224,919	− 2.60	− 1.90
46	Pyrite.....do....	301,458	1,164,871	350,928	1,334,259	+ 49,470	+ 169,388	+ 16.41	+ 14.55
47	Sulphur.....do....	265,664	4,787,049	303,472	5,256,422	+ 37,808	+ 469,373	+ 14.23	+ 9.81
48	Sulphuric acid (60° Baumé, from copper and zinc smelters).....short tons..	438,300	2,733,696	614,073	4,240,941	+ 175,773	+ 1,507,245	+ 40.10	+ 55.14
49	Salt.....barrels (280 lbs. net)..	31,183,968	8,345,692	33,324,808	9,402,772	+ 2,140,832	+ 1,057,080	+ 6.87	+ 12.67
50	Barytes, crude.....short tons..	38,445	122,792	37,478	153,313	− 965	+ 30,521	− 2.51	+ 24.86
51	Cobalt oxide.....pounds..								
52	Mineral paints[m].....short tons..	143,350	7,842,583	181,154	10,069.588	+ 37,804	+ 2,227,005	+ 26.37	+ 28.40
53	Zinc oxide.....do....								
54	Asbestos.....do....	7,604	119,935	4,403	87,959	− 3,201	− 31,976	− 42.10	− 26.66
55	Asphalt.....do....	364,266	3,991,109	449,510	4,620,731	+ 85,244	+ 629,622	+ 23.40	+ 15.78
56	Bauxite.....long tons..	155,618	750,649	159,865	768,932	+ 4,247	+ 18,283	+ 2.70	+ 2.43
57	Chromic iron ore.....do....	120	1,629	201	2,753	+ 81	+ 1,124	+ 67.50	+ 69.00
58	Feldspar.....short tons..	92,700	579,008	86,572	520,562	− 6,128	− 58,446	− 6.61	− 10.10
59	Fuller's earth.....do....	40,697	383,124	32,715	305,522	− 7,982	− 77,602	− 19.61	− 20.26
60	Gems and precious stones.....		343,692		319,722		− 23,970		− 6.97
61	Graphite.....{crystalline, pounds.....	4,790,000	256,050	3,543,771	187,689	− 1,246,229	− 68,361	− 26.02	− 26.70
	{amorphous, short tons..	1,223	32,415	923	24,344	− 300	− 8,071	− 24.53	− 24.81
62	Magnesite.....short tons..	9,375	75,000	10,512	105,120	+ 1,137	+ 30,120	+ 12.13	+ 40.16

a Marketed production of iron ore—1911: 41,092,447 long tons; value at mines, $86,716,575; 1912: 57,017,614 long tons; value at mines, $107,050,153.

b By "spot" value is meant value at the point of production.

c Ferro-alloys include ferromanganese and spiegeleisen, ferrosilicon and ferrophosphorus, ferromolybdenum, ferrotitanium, ferrotungsten, and ferrovanadium. The ferro-alloys are made chiefly of foreign ores. Pig iron in 1910 included ferro-alloys, valued at $7,423,502.

d Average price per troy ounce in 1911 was 53 cents; in 1912 it was 61.5 cents.

e Prior to 1905, coining value $20.6718 per troy ounce; in 1905, coining value, $20.671834; since 1905, coining value, $20.671834625323.

f The product from domestic ores only.

g Includes antimony smelted from imported ores, and also antimony contained in hard lead, before 1907.

h Includes nickel in copper-nickel alloy and in exported ore and matte.

i Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania. Coke, 1911: 35,551,489 short tons; value at ovens, $84,130,849; 1912: 43,893,599 short tons; value at ovens, $111,736,696.

j Value of clay mined and sold as unmanufactured clay—1911: $3,480,763; 1912: $3,946,020.

k Includes limestone for iron flux, but not grindstones.

l Included under feldspar and quartz.

m Includes since 1904 metallic paint, mortar colors, ocher, umber, sienna, shale, ground slate; since 1907, also sublimed blue lead, sublimed white lead, zinc-lead, and leaded zinc oxide; in 1910, also whiting; in 1911 and 1912, also zinc oxide.

Mineral products of the United States in 1911 and 1912—Continued.

	Product.	1911		1912		Increase (+) or decrease (−) in 1912.		Percentage of increase (+) or decrease (−) in 1912.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	NONMETALS (spot value)—continued.								
63	Manganese ore.....long tons..	2,457	$24,586	1,664	$15,723	− 793	− $8,863	− 32.28	− 36.05
64	Manganiferous ore.....do....	44,437	114,918	51,517	19,942	+ 7,080	− 94,976	+ 15.93	− 82.65
65	Mica.....{sheet, pounds.....	1,887,201	310,254	845,483	282,823	− 1,041,718	− 27,431	− 55.20	− 8.84
	{scrap, short tons..	3,512	45,550	3,226	49,073	− 286	+ 3,523	− 8.14	+ 7.73
66	Mineral waters.....gallons sold..	63,788,552	6,837,888	62,281,201	6,615,671	− 1,507,351	− 222,217	− 2.36	− 3.25
67	Quartz.....short tons..	87,943	155,122	97,847	191,685	+ 9,931	+ 36,563	+ 11.29	+ 23.57
68	Talc and soapstone.....do....	81,521	1,032,732	92,403	1,050,693	+ 10,882	+ 17,961	+ 13.35	+ 1.74
69	Talc, fibrous.....do....	62,030	613,286	66,867	656,270	+ 4,837	+ 42,984	+ 7.80	+ 7.01
70	Thorium minerals (monazite) and zircon, pounds.....	3,208	802	.....	.....	.....	.....	.....	.....
71	Titanium ore (rutile).....pounds..	.....	.....	550,000	(a)	.....	.....	.....	.....
72	Tungsten ore.....short tons..	1,139	407,985	1,330	502,158	+ 191	+ 94,173	+ 16.77	+ 23.06
73	Uranium and vanadium minerals....do..	.....	305,500	.....	(a)	.....	.....	.....	.....
74	Total value of nonmetals.....	.....	1,246,750,346	.....	1,376,027,241	.....	+129,276,895	.....	+ 10.37
75	Total value of metals.....	.....	680,531,782	.....	867,103,085	.....	+186,571,303	.....	+ 27.42
76	Estimated value of mineral products unspecified[a].....	.....	250,000	.....	500,000	.....	+ 250,000	.....	+100.00
77	Grand total.....	.....	1,927,532,128	.....	2,243,630,326	.....	+316,098,198	.....	+ 16.40

[a] Includes nitrate of soda, carbonate of soda, sulphate of soda, and alum clays used by paper manufacturers; and cadmium, rutile, selenium, uranium, and vanadium, valued together in 1912 at about $500,000.

TOTAL VALUE OF MINERAL PRODUCTION OF THE UNITED STATES FROM 1880 TO 1912.

The following table and diagram show the value, year by year, of the mineral production of the United States as reported to the United States Geological Survey from 1880 to 1912, inclusive:

Total value of mineral production of the United States from 1880 to 1912, by years.

Year.	Metals.	Nonmetals.	Unspecified products.	Total.
1880	$185,649,163	$173,279,135	$6,000,000	$364,928,298
1881	187,549,908	206,783,144	6,500,000	400,833,052
1882	214,061,009	231,340,150	6,500,000	451,901,159
1883	196,547,259	243,812,214	6,500,000	446,859,473
1884	179,230,899	221,879,506	5,000,000	406,110,405
1885	172,491,087	241,312,093	5,000,000	418,803,180
1886	203,249,225	230,088,769	800,000	434,137,994
1887	236,598,254	270,989,420	800,000	508,387,674
1888	237,574,422	286,150,114	900,000	524,624,536
1889	247,768,701	282,623,812	1,000,000	531,392,513
1890	292,649,877	312,826,503	1,000,000	606,476,380
1891	282,617,183	321,767,846	1,000,000	605,385,029
1892	281,514,539	340,028,842	1,000,000	622,543,381
1893	219,436,649	323,257,318	1,000,000	543,693,967
1894	185,804,594	362,570,173	1,000,000	549,374,767
1895	245,874,431	393,897,097	1,000,000	640,771,528
1896	251,445,519	388,098,702	1,000,000	640,544,221
1897	265,209,975	380,782,607	1,000,000	646,992,582
1898	305,482,183	417,790,671	1,000,000	724,272,854
1899	487,831,631	525,524,074	1,000,000	1,014,355,705
1900	511,632,891	594,398,501	1,000,000	1,107,031,392
1901	480,006,859	660,850,112	1,000,000	1,141,856,971
1902	599,916,009	722,027,126	1,000,000	1,322,943,135
1903	583,433,948	905,242,380	1,000,000	1,489,676,328
1904	502,149,624	859,543,144	400,000	1,362,092,768
1905	700,418,946	921,727,456	400,000	1,622,546,402
1906	886,110,856	1,017,700,525	200,000	1,904,011,381
1907	904,855,142	1,167,711,497	100,000	2,072,666,639
1908	549,923,116	1,044,398,939	250,000	1,594,572,055
1909	754,281,705	1,133,000,740	300,000	1,887,582,445
1910	749,285,310	1,242,820,417	300,000	1,992,405,727
1911	680,531,782	1,246,750,346	250,000	1,927,532,128
1912	867,103,085	1,376,027,241	500,000	2,243,630,326
Grand total	13,648,235,781	19,046,971,275	55,700,000	32,750,936,395

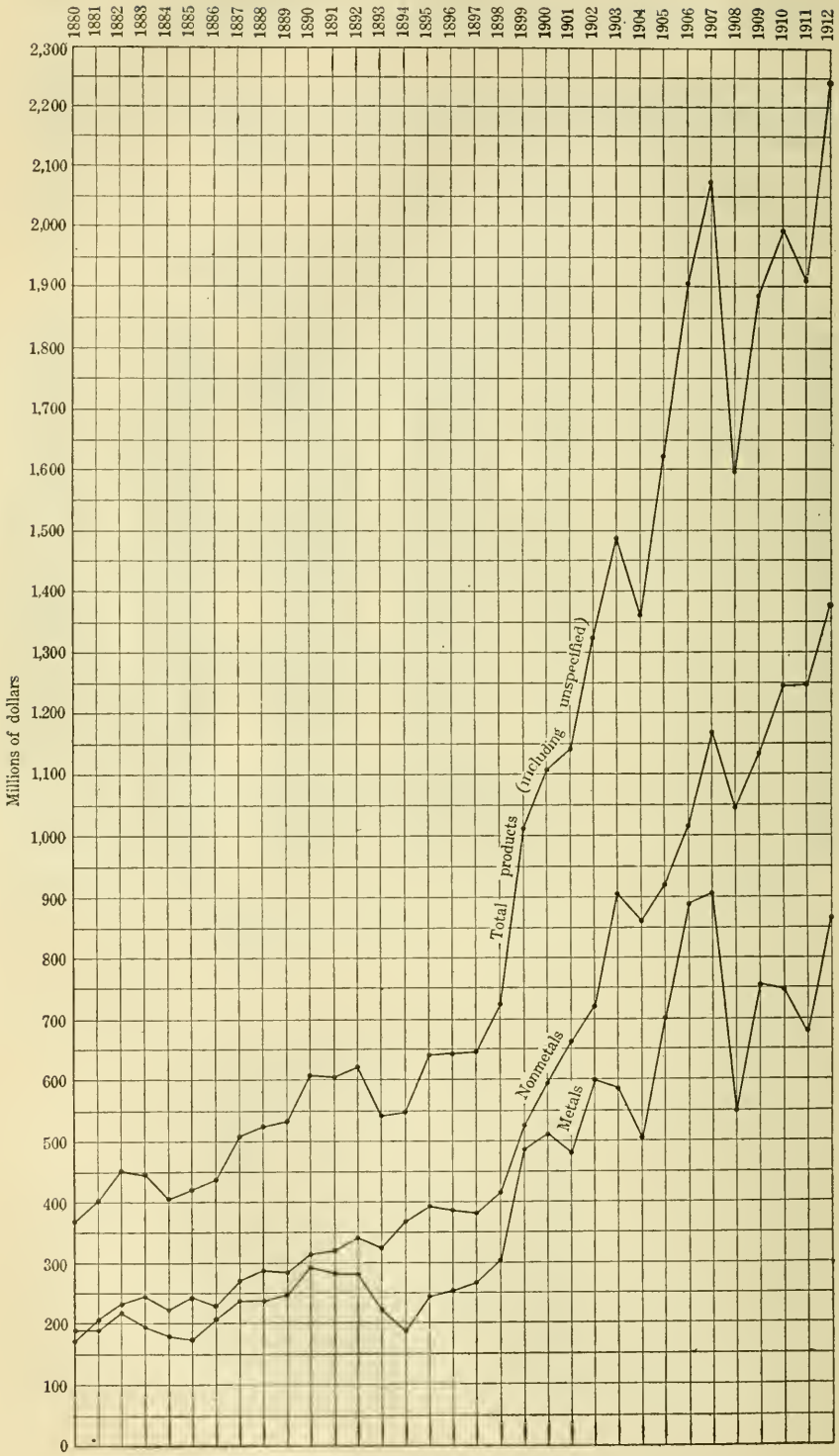

FIGURE 1.—Value of mineral production in the United States, 1880–1912.

IMPORTS AND EXPORTS.

The following table shows the value for the calendar years 1911 and 1912 of the imports for consumption and of the exports of the mineral products included in this report as furnished by the Bureau of Foreign and Domestic Commerce of the Department of Commerce and Labor. As has been noted elsewhere, "imports for consumption" may or may not be identical with "total imports" for the calendar year. Thus, total imports valued at $500,000 may all be entered for consumption, or $50,000 of these imports may be entered in bond and be reported for consumption in the following calendar year. These differences tend to equalize. Thus, in the five years from 1903 to 1907, inclusive, the general imports of iron ores exceeded the imports for consumption by less than 7,500 long tons in total imports of over 4,603,000 tons. The difference for a single year may, however, be considerable.

The imports of nonmetallic products increased in value $11,934,982, or 9.43 per cent, from $126,564,582 in 1911 to $138,499,564 in 1912, and the exports increased $27,568,660, or 14.43 per cent, from $191,077,253 in 1911 to $218,645,913 in 1912. The total imports of mineral products, metals (exclusive of gold and silver) and nonmetals, increased $43,173,149, or 18.64 per cent, and the total exports in 1912 increased $53,047,564, or 17.03 per cent; the exports of metals (exclusive of gold and silver) increased $25,478,904, or 21.16 per cent, and the exports of nonmetals increased about $27,568,660, or 14.43 per cent. Copper constituted about 89 per cent of the metallic exports, and petroleum and its derivatives about 61 per cent of the nonmetallic exports. Copper constituted about 42 per cent and tin about 37 per cent of the imported metals; gems and precious stones made up about 39 per cent and fertilizers almost 26 per cent of the nonmetallic imports.

Value of imports for consumption and of exports of mineral products in the calendar years 1911 and 1912.

METALS.

Product.	1911	1912
IMPORTS.		
Aluminum salts	$56,833	$84,606
Antimony (metal, regulus, and ore)	531,011	859,917
Antimony salts	54,426	81,077
Bauxite	164,301	95,431
Bismuth	311,771	316,440
Cadmium	3,870	3,764
Chromic iron ore	407,958	499,818
Chromium salts	3,508	4,461
Cobalt (oxide, ore, and zaffer)	59,151	83,080
Copper, in ore, matte, ingots, bars, manufactures, etc	38,445,939	57,012,057
Iron ore	5,412,636	6,499,690
Ferroalloys:		
Ferrochrome	27,902	77,587
Ferromanganese	3,015,062	3,906,920
Ferromolybdenum	11,409	4,670
Ferrophosphorus	8,520	4,465
Ferrosilicon	341,681	446,456
Ferrotitanium	22,500	7,631
Ferrotungsten	143,802	323,872
Ferrovanadium	2,623	.....
Spiegeleisen	405,444	28,094
Lead, in ore, base bullion, pigs, sheets, manufactures, etc	631,654	605,551
Manganese ore	1,186,791	1,769,184

Value of imports for consumption and of exports of mineral products in the calendar years 1911 and 1912—Continued.

METALS—continued.

Product.	1911	1912
IMPORTS—continued.		
Nickel, in ore, matte, oxide, etc	$4,050,030	$5,761,967
Platinum	4,866,207	4,503,682
Quicksilver	251,386	39,920
Tin	43,584,219	50,768,955
Tungsten ore	85,887	362,422
Type metal	310,658	18,668
Uranium salts and oxide	14,106	14,357
Zinc, in ore, pigs, sheets, dust, manufactures, etc	408,299	1,952,011
Iridium, osmium, palladium, and rhodium	292,399	213,397
Total	105,111,983	136,350,150
Increase		31,238,167
Percentage of increase		29.72
EXPORTS.		
Aluminum and manufactures, etc	1,158,603	1,347,621
Copper, in ore, matte, ingots, bars, manufactures, etc	105,679,926	129,973,387
Iron ore	2,653,448	3,537,289
Lead, in ore, base bullion, pigs, sheets, manufactures, etc	680,419	651,459
Nickel, in ore, matte, oxide, etc	8,283,777	8,515,332
Quicksilver	13,995	13,360
Zinc, in ore, pigs, sheets, dust, manufactures, etc	1,935,677	1,846,301
Total	120,405,845	145,884,749
Increase		25,478,904
Percentage of increase		21.16

NONMETALS.

Product.	1911	1912
IMPORTS.		
Alizarin	$996,794	$1,514,344
Aniline salts	410,193	354,226
Arsenic sulphides, etc	247,323	428,741
Asbestos	1,703,639	1,819,771
Asphalt	789,236	921,145
Barytes	58,726	79,315
Barium compounds	398,213	376,017
Borax	23,628	11,249
Burrstones and millstones	36,028	27,562
Cement, hydraulic	242,722	93,558
Clay	235,254	323,131
Clay products:		
Brick and tile, etc	166,133	166,322
Pottery, etc	10,638,616	9,555,530
Coal:		
Anthracite	12,550	8,329
Bituminous	3,604,797	4,509,066
Coal-tar products	8,232,411	8,862,317
Coke	254,455	488,398
Corundum and emery	336,644	501,725
Cryolite	47,093	48,293
Fertilizers:		
Crude (guano, kainite, manure salts, phosphates, etc.)	10,762,472	8,893,090
Potassium chloride	7,651,693	7,229,121
Potassium sulphate	2,240,631	1,783,846
Other potassium salts	1,891,057	1,679,318
Sodium nitrate	16,814,268	16,544,511
Flint and flint pebbles	236,158	292,052
Fluorspar	80,592	71,616
Fuller's earth	143,594	145,337
Gems and precious stones	40,820,436	41,363,325
Granite	146,468	112,338
Graphite	1,495,729	1,709,337
Grindstones	123,727	131,080
Gypsum	450,806	488,481
Hones, oilstones, whetstones	54,379	45,398
Infusorial earth and rotten stone	35,665	24,253
Kaolin or china clay	1,461,068	1,629,105

Value of imports for consumption and of exports of mineral products in the calendar years 1911 and 1912—Continued.

NONMETALS—continued.

Product.	1911	1912
IMPORTS—continued.		
Lead paints—litharge, orange mineral, red lead, white lead	$118,395	$119,812
Lime	55,255	48,153
Magnesite and magnesia	1,224,987	1,430,457
Marble and stone	1,409,930	1,549,893
Mica	502,163	748,973
Mineral waters	1,037,485	930,091
Monazite and thorium oxide	60,542	47,334
Ocher	110,932	148,306
Peat	39,372	39,867
Petroleum	2,410,884	6,082,881
Ozokerite and paraffin	792,818	1,018,524
Pumice	118,977	74,478
Pyrite	3,788,803	3,841,683
Salt	375,030	370,648
Sand and gravel	147,268	141,690
Sienna and umber	59,334	77,420
Slate	8,367	14,768
Salicylic acid	3,480	9,543
Sulphur	552,836	583,974
Talc	88,050	122,956
Thorium nitrate	238,841	225,386
Venetian red	20,169	22,916
Zinc oxide	357,466	386,153
Total	126,564,582	138,499,564
Increase	.....	11,934,982
Percentage of increase	.....	9.43
Grand total imports	231,676,765	274,849,714
Increase	.....	43,172,949
Percentage of increase	.....	18.64
EXPORTS.		
Asphalt	[a] 868,552	[a] 1,170,882
Cement, hydraulic	4,632,215	6,160,341
Clay products:		
Brick and tile, etc	2,264,354	3,823,111
Pottery, etc	1,401,366	1,177,784
Coal:		
Anthracite	18,093,285	19,425,263
Bituminous	[b] 34,499,989	[b] 36,817,633
Coke	3,215,990	3,002,742
Fertilizers, phosphates, crude	9,235,388	8,996,456
Lime	153,212	199,515
Marble and stone	1,810,182	1,839,878
Petroleum	105,922,848	124,210,382
Paraffin and paraffin wax	7,047,856	9,602,758
Salt	335,285	418,525
Sulphur	545,420	552,941
Zinc oxide	1,051,311	1,247,702
Total exports	191,077,253	218,645,913
Increase	.....	27,568,660
Percentage of increase	.....	14.43
Grand total exports	311,483,098	364,530,662
Increase	.....	53,047,564
Percentage of increase	.....	17.03

[a] Asphalt and manufactures of, fiscal year.
[b] Not including bunker coal laden as fuel in vessels in the foreign trade, which aggregated in value $21,473,111 in 1911, $23,602,598 in 1912; reported separately by Bureau of Foreign and Domestic Commerce.

If gold and silver are included, for the sake of rounding out the metals mentioned in this report, the metallic imports increased from $206,303,738 in 1911 to $251,300,008 in 1912, and the metallic exports increased from $223,253,565 in 1911 to $265,271,346 in 1912; the total imports increased from $332,868,320 in 1911 to $389,799,572 in 1912, and the total exports increased from $414,330,818 in 1911 to $473,917,259 in 1912. The movements of gold and silver, however, are rather financial than commercial; nevertheless the following table is added to show the results mentioned above:

Value of imports for consumption and of exports of mineral products in the calendar years 1911 and 1912, including gold and silver.

Product.	1911	1912
IMPORTS.		
Gold (ore, bullion, and coin)	$57,445,184	$66,548,772
Silver (ore, bullion, and coin)	43,746,571	48,401,086
Other metals	105,111,983	136,350,150
Total	206,303,738	251,300,008
Total metals	206,303,738	251,300,008
Total nonmetals	126,564,582	138,499,564
Grand total	332,868,320	389,799,572
EXPORTS.		
Gold (ore, bullion, and coin)	37,183,074	47,424,842
Silver (ore, bullion, and coin)	65,664,646	71,961,755
Other metals	120,405,845	145,884,749
Total	223,253,565	265,271,346
Total metals	223,253,565	265,271,346
Total nonmetals	191,077.253	218,645,913
Grand total	414,330,818	473,917,259

METALS AND METALLIC ORES IN 1911 AND 1912.

By J. P. Dunlop.

INTRODUCTION.

For the calendar years 1908 and 1909 the Survey published a summary, by Waldemar Lindgren, and for 1910 and 1911, by H. D. McCaskey, of the domestic production of metals—divided into output from domestic and from foreign sources and measured for uniformity throughout by the short ton of 2,000 pounds—and of the domestic output of metallic ores by classes, measured also by the short ton. For purposes of comparison and contrast this summary filled a need not otherwise supplied, and similar data are here given for 1912.

In the detailed chapters on the various metals in Part I of Mineral Resources of the United States (to which the reader should refer for full information on the metallic resources and industries) the production is measured in terms of the customary unit, whether the long ton of 2,240 pounds, the metric ton of 2,204.6 pounds, the short ton of 2,000 pounds, the "flask" of 75 pounds, the avoirdupois pound, or the troy ounce. The long ton is used for coal, iron ore, bauxite, pig iron, and steel, particularly in the Eastern States, and for tin, copper, and spelter in England. The metric ton is used on the Continent of Europe, in Mexico, and wherever the metric system is in vogue. The "flask" is the customary unit for the measurement of quicksilver except where the metric ton is used; the avoirdupois pound is the unit referred to in defining the tons and the "flask," and is also used for measuring the output of copper, lead, spelter, aluminum, nickel, etc.; the short ton is used for both ore and concentrates in the West, as well as for lead and spelter; and the troy ounce is used for gold, silver, and platinum and allied rare metals. Were the metric system in commercial use in the United States, this confusion of terms would be avoided; in its absence the production of this country by metal mines and metallurgical plants is summarized, as stated, in terms of the short ton of 2,000 pounds.

The table of metal production gives in the main the output from plants—mills, smelters, refineries—in the United States, and is essentially a measure of the metallurgical industry, as the supplies of ore, matte, unrefined bullion, etc., treated in this country are from both domestic and foreign sources. The attempt is made at subdivision of these two, however, and the production in marketable form of metals from both domestic and foreign mines is therefore given wherever possible. The table of domestic ore production is a measure of the metal-mining industry of the United States alone.

There are, roughly, four stages to be considered in the production of metal in marketable form from crude ore: (1) Mining, (2) milling and concentrating, (3) smelting, and (4) refining. The first stage produces crude ore; and both straight concentrating and gold and

silver milling plants produce concentrates. Both crude ore and concentrates are treated in both gold and silver amalgamating, cyaniding, and chlorinating plants, and also in smelters, and the products are refined in private refineries and the precious metals in part in the United States mints. As production may be reported, therefore, as metal in raw materials, in unrefined state, or as refined, there may be three sets of figures to reprsent the metal output, and there may be certain discrepancies between these for the same metal for the same calendar year, owing to time difference, customary losses in metallurgical operations, and difference in activity between mining and treating the ore. In this summary the metals are measured as refined.

METALS.

The following tables show the production of metals in the United States in 1911 and 1912:

Production of metals in the United States in 1911 and 1912, in short tons.

1911.

Metal.	Production from domestic ores.		Production from foreign ores, matte, and unrefined bullion smelted or refined in the United States.		Total production.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Iron (pig)	24,980,035	$313,334,558	1,068,127	$14,000,066	26,048,162	$327,334,624
Manganese (spiegeleisen and ferromanganese) [a]	97,894	1,662,810	102,155	3,083,731	200,049	4,746,541
Other ferro alloys [a]	83,281	2,630,186	450	1,001,105	83,731	3,631,291
Nickel [b]	.....	.....	.....	.....	.....	.....
Aluminum	[c] 23,063	8,084,000	.....	.....	23,063	8,084,000
Gold	160.699	96,890,000	30.005	18,091,080	190.704	114,981,080
Silver	2,070.837	32,615,700	2,389.454	36,936,965	4,460.291	69,552,665
Platinum	.022	40,890	.967	1,267,590	.989	1,308,480
Quicksilver	797.100	977,989	.....	.....	797.100	977,989
Tin	5	4,226	.....	.....	5	4,226
Copper, stated as refined	550,635	137,658,750	166,302	41,575,500	716,937	179,234,250
Lead, stated as refined	391,995	35,279,550	94,984	8,548,560	486,979	43,828,110
Antimonial lead	9,636	944,969	4,442	435,587	14,078	1,380,556
Zinc, stated as spelter	271,621	30,964,794	14,905	1,699,170	286,526	32,663,964
Total	.....	661,088,422	.....	126,639,354	.....	787,727,776

1912.

Iron (pig)	32,458,938	$402,378,453	1,343,747	$18,184,935	33,802,685	$420,563,388
Manganese (spiegeleisen and ferromanganese) [a]	114,868	1,962,955	140,423	6,319,051	255,291	8,282,006
Other ferro alloys [a]	109,202	1,901,707	3,633	2,040,063	112,835	3,941,770
Nickel	.....	.....	22,421	17,936,800	22,421	17,936,800
Aluminum	[c] 32,803	15,089,380	.....	.....	32,803	15,089,380
Gold	154.996	93,451,500	33.112	19,964,010	188.108	113,415,510
Silver	2,186.291	39,197,500	2,285.147	40,989,817	4,471.438	80,187,317
Platinum	.018	23,003	1.286	1,709,218	1.304	1,732,221
Quicksilver	939.900	1,057,180	.....	.....	939.900	1,057,180
Tin	.....	.....	8.400	8,850	8.400	8,850
Copper, stated as refined	615,856	203,232,480	118,196	39,004,680	734,052	242,237,160
Lead, stated as refined	392,517	35,326,530	88,377	7,953,930	480,894	43,280,460
Antimonial lead	8,549	826,788	5,003	484,560	13,552	1,311,348
Zinc, stated as spelter	323,907	44,699,166	14,899	2,056,062	338,806	46,755,228
Total	.....	839,146,642	.....	156,651,976	.....	995,798,618

[a] Includes marketed production of ferrosilicon, ferrophosphorus, ferrovanadium, ferrotungsten, ferromolybdenum, ferrotitanium.
[b] Figures not available.
[c] Includes foreign. Figures are consumption, not production.

Pig iron.—The production of pig iron is usually reported by long tons. The output of 1911 was 23,257,288 long tons, and for 1912 it was 30,180,969 long tons.

Manganese (spiegeleisen and ferromanganese).—The figures for the important iron-manganese alloys were formerly published by the Survey combined with those of pig iron. Statistics for their total marketed production are now available separately. The production for both alloys is given as 178,615 long tons in 1911 and 227,939 long tons in 1912.

Ferrosilicon and ferrophosphorus.—The combined marketed production of ferrosilicon and ferrophosphorus was 70,122 long tons in 1911 and 97,371 long tons in 1912.

Other ferro-alloys.—In addition to spiegeleisen, ferromanganese, ferrosilicon, and ferrophosphorus are the ferro-alloys known as ferromolybdenum, ferrotitanium (with 10 to 20 per cent of titanium), ferrovanadium, ferrotungsten (with about 50 per cent of tungsten). The combined output in 1911 was 4,638 long tons, and in 1912 it was 3,375 long tons.

Nickel.—The production of nickel in the United States from domestic ores is merely a by-product from electrolytes of the copper refineries. Salts and metal equivalent to 328 short tons of metallic nickel were reported saved in domestic refineries in 1912 from both foreign and domestic ores. The figures for 1912 given in the table are for content of nickel in ore and matte "imported for consumption," and are mostly from the Canadian (Sudbury) deposits, but New Caledonia nickel was on the market in 1912.

Aluminum.—There is only one producer of aluminum in the United States. The figures given are those for consumption. The statistics are usually reported in pounds and show 47,734,000 pounds for 1910, 46,125,000 pounds for 1911, and 65,607,000 pounds for 1912.

Gold and silver.—The production of gold and silver is usually given in fine ounces troy. The following table gives the output of domestic plants for 1911 and 1912:

Production of gold and silver in 1911 and 1912, in fine ounces troy.

		Domestic.	Foreign.	Total.
Gold	1911	4,687,053	875,156	5,562,209
	1912	4,520,717	965,759	5,486,476
Silver	1911	60,399,400	69,692,387	130,091,787
	1912	63,766,800	66,650,109	130,416,909

The unrefined foreign gold and silver come mainly from Canada, Mexico, Central America, and South America, and considerable ore from which gold and silver are by-products of the smelters in base bullion is also received by domestic plants chiefly from these countries.

Platinum.—The production is usually reported in troy ounces, and the domestic output is from crude platinum from gravels in Oregon and California, from copper-platinum-palladium ore from the Rambler mine in Wyoming, and also from refined metal recovered as a by-product in refining gold and copper bullion from both domestic and foreign ores, and bullion from scrap. The figures are 628 and 1,200 troy ounces, respectively, for 1911, and 505 and 500 troy ounces, respectively, for 1912. The quantity of refined platinum derived from foreign ores and bullion amounted to 37,524 troy ounces in 1912.

Quicksilver.—The domestic production of quicksilver is entirely from domestic ores and is usually reported in flasks of 75 pounds each. The output was 21,256 flasks in 1911 and 25,064 flasks in 1912.

Tin.—The production of tin is usually given in short tons. There was no output from domestic sources, the stream tin from Alaska being shipped to England for smelting. The consumption in the United States is largely supplied by imports, but also by recoveries of secondary tin from old metal. A small quantity of tin ore from Bolivia was smelted in New York.

Copper.—The production of domestic copper is usually reported as blister copper in pounds. The output of blister copper from domestic ores was 1,097,232,749 pounds in 1911 and 1,243,268,720 pounds in 1912. Foreign sources for copper produced and refined in the United States are Mexico, Canada, Peru, Europe, and other countries.

Lead.—The production of lead is usually given in short tons. The imports of foreign material for treatment in domestic plants come mainly from Mexico.

Antimonial lead.—The output of antimonial lead is mainly a metallurgical by-product obtained in refining lead bullion.

Zinc.—The production of metallic zinc or spelter is usually stated in short tons. The figures do not include zinc in pigments. Imports of foreign ores come mainly from Mexico.

METALLIC ORES.

The following table shows the production of crude metallic ores supplied from domestic mines to gold and silver mills, concentrating plants, and smelters:

Production of crude metallic ores from domestic mines in 1911 and 1912, in short tons.

	1911	1912
Iron ores	46,023,540	63,859,728
Manganese ores	2,752	1,864
Manganiferous iron ores	3,006	3,247
Chromium ores	134	225
Tungsten ores	16,500	34,000
Titanium ores		6,900
Aluminum ores	174,292	179,040
Gold ores	9,884,684	9,736,203
Silver ores	739,200	848,574
Quicksilver ores	138,525	155,693
Tin ores	42,200	3,000
Vanadium and uranium ores	8,468	18,000
Copper ores:		
Western States	18,207,566	23,431,301
Central States	10,978,827	11,411,941
Eastern States	801,842	830,089
Total	29,988,235	35,673,331
Copper-lead ores	6,923	14,614
Lead ores:		
Western States	2,157,817	2,388,598
Central States	3,794,712	4,064,366
Eastern States		
Total	5,952,529	6,452,964
Zinc and zinc-lead ores:		
Western States	1,356,781	1,344,222
Central States	10,629,269	11,899,185
Eastern States	413,332	497,832
Total	12,399,382	13,741,239
Grand total	105,380,370	130,728,622

Iron ore.—Under iron ores are included 477,920 short tons of manganiferous iron ores (with low manganese content) in 1911 and 816,984 short tons in 1912 shipped from Lake Superior mines. The Lake Superior and Clinton hematites are usually shipped without concentration, although there is a movement now growing important to wash and concentrate some Lake ores. The eastern brown ores are usually washed to remove clay. The magnetites of New York are in part concentrated to remove apatite. All these ores are reported in the table as shipped or smelted.

Manganese ores.—The production of high-grade manganese ore is mainly from Virginia, but the figures given include some output from California and South Carolina in 1912. The principal uses of manganese ores are for the manufacture of iron-manganese alloys, as fluxes in smelting, as oxidizing and decolorizing agents, for making dry cells, and for coloring glass, brick, and pottery.

Manganiferous iron ore.—The low-grade manganiferous iron ores from the Lake Superior region are included with iron ores in the table. The remaining manganiferous iron ores come mainly from Arkansas and Virginia, and are used chiefly in making high manganese pig iron. Considerable quantities of manganiferous and iron ores, usually argentiferous, are mined in Colorado and elsewhere and are used as fluxes in western lead smelters; they are included under ores of the precious metals.

Chromium ore.—Chromic iron ore or chromite is usually reported in long tons. The output, mainly from California, and used chiefly to supply pigments, in special tanning processes, for furnace linings, and in steel alloys, was 205 long tons in 1910, 120 long tons in 1911, and 201 long tons in 1912, all from California mines. The imports in 1912 were 53,929 long tons, chiefly from Rhodesia and New Caledonia.

Tungsten ore.—Tungsten ore is usually reported in short tons, and that given in the table is in part estimated and includes output from reworking of some hundreds of tons of old tailings. The ordinary commercial basis for tungsten ores in the United States is a content of 60 per cent tungsten trioxide. The metal is chiefly used for making high-speed steels and for making the filament of the tungsten incandescent electric lamp, although the total requirement for this last-named purpose is relatively small.

Vanadium ore.—Production of vanadiferous ores was confined to carnotite and roscoelite ores. There is apparently a growing demand in the steel trade for the metal. The output could not be reported separately for 1910 or 1911 and is given combined with that of uranium ore (carnotite) in the table for 1912.

Titanium ore.—The domestic output of titanium ore has been mainly rutile from Virginia and amounted to 275 tons of metal in 1912. The use is chiefly for making ferrotitanium for steels and titanium carbide for electrodes, and this demand is in part supplied by the use of titaniferous magnetite and ilmenite, both of which are more plentiful and cheaper than rutile.

Aluminum ore.—The figures for aluminum ore given in the table are for domestic output of bauxite. In long tons, as usually reported, the production was 148,932 long tons in 1910, 155,618 long tons in 1911, and 159,865 long tons in 1912. The output is mainly from Arkansas, Georgia, Alabama, and Tennessee. A possible new source of aluminum is alunite, deposits of which have recently been recognized and developed in Utah and elsewhere, attention being called

to them mainly as a new source for potash. The chief uses of bauxite are as raw material in production of metallic aluminum and in the manufacture of aluminum salts, bauxite bricks, and alundum (an abrasive).

Gold ore.—The figures given for gold ore include siliceous, pyritic, and other ores in which the predominant value is for gold. The domestic gold output is derived not only from gold ore, but also from gravels of placer mines. Satisfactory figures for the quantity of gravels washed are not available for 1912, but it is hoped they will be obtained by the Survey for future reports. A portion of the gold output is also derived from copper, lead, and mixed base-metal ores.

Silver ore.—The production of silver ore given is mainly of silver-gold ores in which the value of silver exceeds that of the gold. Of the total production in 1912 Nevada (mainly Tonopah) is credited with 476,725 short tons, New Mexico with 110,127 tons, Utah with 81,234 tons, Colorado with 158,429 tons, Texas with 20,375 tons, and Arizona with 429 tons. The Colorado output is largely of iron-manganese-silver ores from Leadville, used as flux in the lead furnaces. Pure silver ore is rare. About two-thirds of the silver production of the United States is derived as a by-product of lead and copper ores.

Quicksilver ore.—No quicksilver ore is imported. Of the domestic output, ore treated in 1912 included 139,347 short tons, averaging 0.55 per cent of metal, in California, and 16,346 tons, averaging 1.04 per cent, in Texas and Nevada combined. In 1911 the production was 130,926 short tons, averaging 0.54 per cent, in California, and 7,599 tons, averaging 1.18 per cent, in Nevada and Texas combined.

Tin ore.—The domestic production of tin ore was wholly from placer operations in Alaska—and in this case the gravel dredged is estimated in short tons.

Copper ore.—The copper ores of the Western States are in part concentrated and in part smelted crude. Those from Michigan are always concentrated, and those from Tennessee are smelted crude. The total quantity of copper concentrates produced in 1910 was 2,063,824 short tons, in 1911 it was 2,202,590 tons, and in 1912 it was 2,734,065 tons. The increase of over 500,000 tons in 1912 was due to more extended working of low-grade ore deposits in New Mexico, Arizona, and Nevada. The average per cent of copper in crude copper ore concentrated was 1.26. A small part of the domestic copper output is derived from gold, lead, zinc, and mixed ores.

Lead ore.—The lead ores of the Western and the Central States are generally concentrated. The production of lead concentrates from the Central States, mainly from southeastern Missouri, was 260,967 short tons in 1910, 270,883 short tons in 1911, and 256,838 short tons in 1912. The output of lead concentrates in Idaho, the largest producer in the Western States, was 176,704 short tons, and the production in Utah was 107,006 short tons in 1911 and 103,999 short tons in 1912.

Zinc ore.—A considerable part of the production of zinc ore is used in the manufacture of pigments. Except some western ores, which are shipped crude, the zinc ores are generally concentrated. The zinc ore and concentrates of the Eastern States are mainly from Franklin Furnace, N. J., but also from eastern Tennessee, southwestern Virginia, and North Carolina. The output from the Central States is chiefly from Missouri, Wisconsin, Kansas, and Oklahoma,

in the order named, and that from the Western States is mainly from Colorado, Montana, New Mexico, Utah, Nevada, and California.

The following table shows the production of zinc concentrates in 1911 and 1912:

Production of zinc concentrates in 1911 and 1912, in short tons.

	1911	1912
Western States	149,000	169,857
Central States	381,579	424,337
Eastern States	257,133	304,175

IRON ORE, PIG IRON, AND STEEL.

By Ernest F. Burchard.

INTRODUCTION.

Among the most noteworthy features of the iron mining and manufacturing industries in the United States in 1912 was the large increase in the production of iron ore, pig iron, and steel, compared with the output of 1911, and the generally rapid recovery from the industrial stagnation of 1911. The quantity of iron ore mined in 1912 did not quite equal that of the record year, 1910, but the tonnages of pig iron and steel manufactured in 1912 both ran ahead of the output of those metals in 1910. A graphic comparison of the production of iron ore and its derived metals since 1870 is afforded by the curves shown in figure 1.

A new feature of the present report consists in giving detailed tables of both the quantity of iron ore mined in the various States and district and the quantity and value of iron ore marketed. Stocks of ore at mines have been carefully checked and are found to balance closely with ore mined and marketed, although it can not be expected that there will ever be exact accord from year to year between these three sets of figures, since the tonnage of ore in stock piles is necessarily partly estimated and here are generally variations in the mine reports from year to year.

It is believed that all the figures presented in this report covering the years 1911 and 1912, and also certain earlier years, are much more nearly accurate than those given in any former annual report, because a special effort has been made by the Survey, involving much correspondence with mine operators, to obtain a revision of figures for 1911 and 1912 where important discrepancies were found between the items mentioned above. The efforts of the Survey in this direction have been well repaid by the prompt and willing responses of the mine operators. The statistical part of this report is largely the work of Miss M. B. Clark, of the United States Geological Survey.

The present report contains, in addition to the statistics of the iron and steel industries, abstracts of recent Survey reports on iron ore resources in four widely separated areas of the United States—California, Montana, Wisconsin, and the adjoining portions of Tennessee, Alabama, and Georgia.

IRON ORE INDUSTRY IN THE UNITED STATES.

IRON ORE MINED AND MARKETED IN 1912.

The quantity of iron ore mined in the United States in 1912 amounted to 55,150,147 long tons, as compared with 43,876,552 long tons mined in 1911, an increase of 11,273,595 long tons, or 25.69 per cent. The quantity of iron ore marketed in the United States in

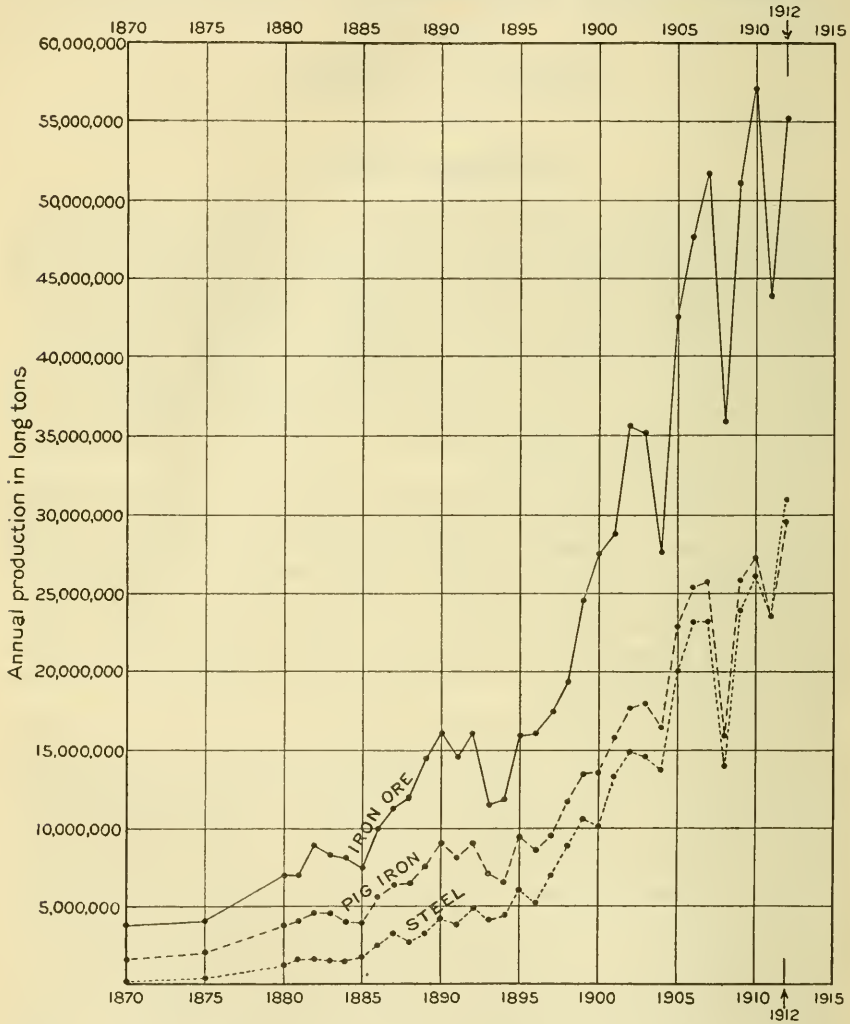

FIGURE 2.—Curve showing the production of iron ore, pig iron, and steel in the United States, 1870–1912.

1912 amounted to 57,017,614 long tons, valued at $107,050,153, as compared with 41,092,447 long tons, valued at $86,716,575, marketed in 1911. This represents an increase in quantity of 15,925,167 long tons, or 38.75 per cent, and in value of $20,333,578, or 23.45 per cent. The average price of ore per ton for the whole country in 1912

was $1.88, as compared with $2.11 in 1911. These quantities of ore, both mined and marketed, include the iron ore used for fluxing other metallic ores at smelters in the Middle and Western States, but do not include the iron ore sold for the manufacture of paint. The quantity of iron ore for paint marketed in 1912, which is reported in detail in another chapter of Mineral Resources, amounted to 13,237 long tons, valued at $35,726. The ore reported as sold for fluxing purposes other than in the manufacture of pig iron amounted to 88,449 long tons, valued at $244,315, in 1912, as compared with 102,639 long tons, valued at $296,745, in 1911. The domestic iron ore actually marketed for the manufacture of pig iron amounted in 1912 to 56,929,165 long tons, valued at $106,805,838, as compared with 40,989,808 long tons, valued at $86,419,830, in 1911.

PRODUCTION OF IRON ORE BY GEOGRAPHIC DISTRICTS.

The States in which iron ore occurs may be conveniently grouped into six geographic districts, namely:

1. *Northeastern district.*—Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Ohio.
2. *Southeastern district.*—Maryland, the Virginias, Kentucky, Tennessee, North Carolina, Georgia, and Alabama.
3. *Lake Superior district.*—Michigan, Wisconsin, and Minnesota.
4. *Mississippi Valley district.*—Iowa, Mississippi, Missouri, Arkansas, and Texas.
5. *Rocky Mountain district.*—Idaho, Montana, Wyoming, Colorado, New Mexico, Utah, and Nevada.
6. *Pacific slope district.*—Washington and California.

Each of these districts may be subdivided into mining districts and the ores classified with regard to variety and to distribution of deposits. These subdivisions are discussed in another section. The Lake Superior is by far the most important of these districts, and is followed in order by the southeastern district and the northeastern district; the Mississippi Valley and the western districts are of minor importance. The following table shows the relative output of iron ore in each of these geographic districts during 1911 and 1912:

Iron ore mined in the United States, by geographic districts, in 1911 and 1912, in long tons.

District.	1911		1912	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Northeastern	2,098,923	4.79	2,139,058	3.88
Southeastern	5,291,879	12.06	5,665,386	10.27
Lake Superior [a]	35,672,804	81.30	46,483,798	84.29
Mississippi Valley	65,975	.15	46,480	.08
Rocky Mountain	746,971	1.70	812,917	1.48
Pacific slope	(b)	.....	2,508	.....
Total	43,876,552	100.00	55,150,147	100.00

[a] Includes all Wisconsin mines.
[b] Pacific slope included in Rocky Mountain district.

PRODUCTION OF IRON ORE BY STATES.

Iron ore was mined in 27 States in 1912, as well as in 1911. Of these States, four—Idaho, Montana, Nevada, and Utah—produced ores for fluxing only; part of Colorado's production was for fluxing and part for pig iron; Michigan produced a very small quantity for flux, and a small quantity was produced in Missouri for special fluxing use; the remaining States produced iron ore for blast-furnace use only.

The rank of the five States producing the largest quantity of iron ore—Minnesota, Michigan, Alabama, New York, and Wisconsin—remained unchanged in 1912, but there were a few changes in the relative rank of certain of the smaller producers. For instance, in 1911 Virginia ranked sixth and Pennsylvania seventh, but the rank of these two States was reversed in 1912. Likewise, the rank of New Jersey and Tennessee, respectively eighth and ninth in 1911, was reversed in 1912. The increase in quantity of ore mined in 1912 was made by the mines in the five States of largest production mentioned above; nearly all the other States showed a decrease.

MINNESOTA PRODUCED FIVE-EIGHTHS OF TOTAL.

The Minnesota iron ranges are producing at present considerably more iron ore than is produced in all the rest of the States together, having furnished nearly 62.5 per cent of the total for the United States in 1912. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 46,368,878 tons in 1912, or nearly 84.08 per cent of the total.

Of the two following tables the first gives a comparison of the iron ore mined and marketed by States for 1911 and 1912, showing the rank of each State and the percentage of the total mined and marketed in the several States, and the second shows the quantity and value of the iron ore marketed in 1911 and 1912, by States, together with the increase or decrease in tonnage and the percentage of increase or decrease in the various States.

Rank of States in mined and in marketed production of iron ore, 1911 and 1912.

1911.

State.	Mined.		
	Rank.	Quantity, in long tons.	Percentage of total.
Minnesota	1	24,645,105	56.17
Michigan	2	10,329,039	23.54
Alabama	3	3,827,791	8.72
New York	4	1,061,279	2.42
Wisconsin	5	698,660	1.59
Virginia	6	614,023	1.40
Pennsylvania	7	537,506	1.23
New Jersey	8	466,234	1.06
Tennessee	9	463,835	1.06
Georgia	10	203,889	.46
Missouri	11	65,325	.15
Utah	12	39,903	.09
Ohio	13	15,707	.04
Other States[a]	.....	908,256	2.07
Total	.....	43,876,552	100.00

State.	Marketed.					
	Quantity.			Value.		
	Rank.	Long tons.	Percentage of total.	Rank.	Amount.	Percentage of total.
Minnesota	1	23,398,406	56.94	1	$48,447,760	55.87
Michigan	2	8,945,103	21.77	2	23,810,710	27.46
Alabama	3	3,955,582	9.63	3	4,876,106	5.62
New York	4	1,057,984	2.58	4	2,959,009	3.41
Virginia	5	610,871	1.49	7	1,146,188	1.32
Wisconsin	6	559,763	1.36	5	1,386,616	1.60
Pennsylvania	7	514,929	1.25	9	539,553	.62
Tennessee	8	469,728	1.14	8	632,339	.73
New Jersey	9	359,721	.88	6	1,158,271	1.34
Georgia	10	207,279	.50	10	315,704	.36
Missouri	11	72,810	.18	11	153,776	.18
Utah	12	34,528	.08	12	123,302	.14
Ohio	13	16,697	.04	13	30,549	.04
Other States[a]	.....	889,046	2.16	.....	1,136,692	1.31
Total	.....	41,092,447	100.00	.....	86,716,575	100.00

[a] California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Mississippi, Montana, Nevada, New Mexico, North Carolina, West Virginia, and Wyoming.

Rank of States in mined and in marketed production of iron ore, 1911 and 1912—Contd.

1912.

State.	Mined.		
	Rank.	Quantity, in long tons.	Percentage of total.
Minnesota	1	34,431,768	62.43
Michigan	2	11,191,430	20.29
Alabama	3	4,563,603	8.28
New York	4	1,216,672	2.21
Wisconsin	5	860,600	1.56
Pennsylvania	6	517,081	.94
Virginia	7	446,305	.81
Tennessee	8	416,885	.76
New Jersey	9	364,673	.66
Georgia	10	134,637	.24
Missouri	11	43,480	.08
Ohio	12	10,346	.02
Utah	13	7,280	.01
Other States [a]	.....	945,387	1.71
Total	.....	55,150,147	100.00

State.	Marketed.					
	Quantity.			Value.		
	Rank.	Long tons.	Percentage of total.	Rank.	Amount.	Percentage of total.
Minnesota	1	34,249,813	60.07	1	$61,805,017	57.74
Michigan	2	12,797,468	22.44	2	29,003,163	27.09
Alabama	3	4,776,545	8.38	3	5,734,371	5.36
New York	4	1,167,405	2.05	4	2,933,024	2.74
Wisconsin	5	1,152,250	2.02	5	2,731,574	2.55
Pennsylvania	6	522,172	.92	9	481,353	.45
Tennessee	7	416,885	.73	8	564,443	.53
Virginia	8	412,520	.72	7	903,130	.84
New Jersey	9	366,823	.64	6	1,192,816	1.11
Georgia	10	135,337	.24	10	227,282	.21
Missouri	11	42,120	.07	11	92,996	.09
Ohio	12	20,861	.04	12	40,986	.04
Utah	13	7,280	.01	13	22,586	.02
Other States [a]	.....	950,135	1.67	.....	1,317,412	1.23
Total	.....	57,017,614	100.00	.....	107,050,153	100.00

[a] California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Montana, Nevada, New Mexico, North Carolina, Texas, West Virginia, and Wyoming.

Quantity and value of iron ore marketed in the United States, 1911 and 1912, by States.

State.	1911		1912		Increase (+) or decrease (−) in 1912.		Percentage of increase (+) or decrease(−)in 1912.	
	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity.	Value.
Alabama	3,955,582	$4,876,106	4,776,545	$5,734,371	+ 820,963	+ $858,265	+ 20.75	+17.60
Georgia	207,279	315,704	135,337	227,282	− 71,942	− 88,422	− 34.71	−28.01
Michigan	8,945,103	23,810,710	12,797,468	29,003,163	+ 3,852,365	+ 5,192,453	+ 43.07	+21.81
Minnesota	23,398,406	48,447,760	34,249,813	61,805,017	+10,851,407	+13,357,257	+ 46.38	+27.57
Missouri	72,810	153,776	42,120	92,996	− 30,690	− 60,780	− 42.15	−39.53
New Jersey	359,721	1,158,271	366,823	1,192,816	+ 7,102	+ 34,545	+ 1.97	+ 2.98
New York	1,057,984	2,959,009	1,167,405	2,933,024	+ 109,421	− 25,985	+ 10.34	− .88
Ohio	16,697	30,549	20,861	40,986	+ 4,164	+ 10,437	+ 24.94	+34.16
Pennsylvania	514,929	539,553	522,172	481,353	+ 7,243	− 58,200	+ 1.41	−10.79
Tennessee	469,728	632,339	416,885	564,443	− 52,843	− 67,896	− 11.25	−10.74
Utah	34,528	123,302	7,280	22,586	− 27,248	− 100,716	− 78.92	−81.68
Virginia	610,871	1,146,188	412,520	903,130	− 198,351	− 243,058	− 32.47	−21.21
Wisconsin	559,763	1,386,616	1,152,250	2,731,574	+ 592,487	+ 1,344,958	+105.85	+97.00
Other States [a]	889,046	1,136,692	950,135	1,317,412	+ 61,089	+ 180,720	+ 6.87	+15.81
Total	41,092,447	86,716,575	57,017,614	107,050,153	+15,925,167	+20,333,578	+ 38.75	+23.45

[a] 1911: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Mississippi, Montana, Nevada, New Mexico, North Carolina, West Virginia, and Wyoming; 1912: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Montana, Nevada, New Mexico, North Carolina, Texas, West Virginia, and Wyoming.

PRODUCTION OF IRON ORE BY VARIETIES BY STATES AND MINING DISTRICTS.

Iron minerals are classified as sulphides, oxides, carbonates, silicates, etc., of which only the oxides and the carbonates are used in the iron and steel industry, except a very small quantity of by-product from sulphide ores used in acid manufacture. The ores of iron are generally classed under four heads:

1. *Hematite.*—Including all varieties of the anhydrous sesquioxid (Fe_2O_3–theoretical percentage of iron, 70). This is known locally as red hematite, specular ore, gray ore, fossil ore, oolitic ore, etc.

2. *Brown ore.*—Including hydrated sesquioxides, such as limonite, göthite, and turgite ($Fe_2O_3nH_2O$—theoretical percentage of iron, 59.8–66). This is known locally as brown iron ore, brown hematite, bog ore, limonite, etc.

3. *Magnetite.*—Including magnetic oxides (Fe_3O_4—theoretical percentage of iron, 72.4). Magnetite is known generally as magnetic iron ore.

4. *Iron carbonate.*—Including carbonates of various types ($FeCO_3$—theoretical percentage of iron, 48.2). Iron carbonate is known locally as spathic iron ore, kidney ore, black band ore, siderite, etc.

Hematite has always been predominant as an ore of iron, and at present constitutes more than nine-tenths of the iron ore produced in the United States. Brown ore and magnetite are far below it in importance; brown ore furnishes at present less than 3 per cent, and magnetite a little less than 4 per cent of the total iron-ore production. The production of iron carbonate is insignificant in comparison with that of the other ores; in 1912 it constitutes only about 0.02 per cent of the total.

In the following tables are shown the quantities of each of the classes of iron ores mined in the various States and mining districts during 1911 and 1912.

Iron ore mined in the United States in 1911 and 1912, by States and varieties, with percentage of increase or decrease in 1912, in long tons.

1911.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.
Alabama	2,983,440	844,351	.....	.....	3,827,791
Georgia	14,955	188,934	.....	.....	203,889
Michigan	10,329,039	.....	.....	.....	10,329,039
Minnesota	24,645,105	.....	.....	.....	24,645,105
Missouri	57,201	8,124	.....	.....	65,325
New Jersey	.....	2,182	464,052	.....	466,234
New York	32,048	.....	1,029,231	.....	1,061,279
Ohio	.....	.....	.....	15,707	15,707
Pennsylvania	9,692	49,906	477,908	.....	537,506
Tennessee	255,373	208,462	.....	.....	463,835
Utah	.....	39,903	.....	.....	39,903
Virginia	63,019	550,142	862	.....	614,023
Wisconsin	698,660	.....	.....	.....	698,660
Other States [a]	537,692	140,090	230,474	.....	908,256
Total	39,626,224	2,032,094	2,202,527	15,707	43,876,552

[a] California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Mississippi, Montana Nevada, New Mexico, North Carolina, West Virginia, and Wyoming.

1912.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.	Percentage of increase (+) or decrease (—) in 1912.
Alabama	3,814,361	749,242	.....	.....	4,563,603	+ 19.22
California	.....	.....	2,508	.....	2,508	([a])
Georgia	([b])	[b] 134,637	.....	.....	134,637	— 33.97
Kentucky	27,373	.....	.....	.....	27,373	([a])
Maryland	.....	3,200	.....	.....	3,200	([a])
Michigan	11,191,430	.....	.....	.....	11,191,430	+ 8.35
Minnesota	34,431,768	.....	.....	.....	34,431,768	+ 39.71
Missouri	39,721	3,759	.....	.....	43,480	— 33.44
New Jersey	.....	.....	364,673	.....	364,673	— 21.78
New York	106,327	.....	1,110,345	.....	1,216,672	+ 14.64
North Carolina	.....	.....	68,322	.....	68,322	([a])
Ohio	.....	.....	.....	10,346	10,346	— 34.13
Pennsylvania	10,557	30,371	476,153	.....	517,081	— 3.80
Tennessee	245,754	171,131	.....	.....	416,885	— 10.12
Texas	.....	3,000	.....	.....	3,000	([a])
Utah	.....	7,280	.....	.....	7,280	— 81.76
Virginia	47,472	398,833	.....	.....	446,305	— 27.31
West Virginia	.....	5,061	.....	.....	5,061	([a])
Wisconsin	860,600	.....	.....	.....	860,600	+ 23.18
Other States [c]	562,219	116,172	157,532	.....	835,923	+ [a] 4.09
Total	51,345,782	1,614,486	2,179,533	10,346	55,150,147	+ 25.69

[a] Less than three producers in California, Kentucky, Maryland, North Carolina, Texas, and West Virginia in 1911, and permission not secured to publish State totals. Increases and decreases in 1912, therefore, included in "Other States."

[b] Hematite included in brown ore.

[c] Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, New Mexico, and Wyoming.

Iron ore mined in the United States, by mining districts and varieties, in 1911 and 1912, with percentage of increase or decrease in 1912, in long tons.

1911.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
Lake Superior [a]	35,550,225				35,550,225
Birmingham	2,719,059	422,841			3,141,900
Chattanooga	522,084	394,053			916,137
Adirondack			885,827		885,827
Northern New Jersey and southeastern New York		2,182	587,326		589,508
Other	834,856	1,213,018	729,374	15,707	2,792,955
Total	39,626,224	2,032,094	2,202,527	15,707	43,876,552

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district.

1912.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.	Percentage of increase (+) or decrease (−) in 1912.
Lake Superior [a]	46,368,878				46,368,878	+30.43
Birmingham	3,537,433	420,310			3,957,743	+25.97
Chattanooga	518,536	259,984			778,520	−15.02
Adirondack			965,736		965,736	+9.02
Northern New Jersey and southeastern New York			509,282		509,282	−13.61
Other	920,935	934,192	704,515	10,346	2,569,988	− 7.98
Total	51,345,782	1,614,486	2,179,533	10,346	55,150,147	+25.69

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district.

These tables show that the great bulk of the hematite comes from the Lake Superior district (Michigan, Minnesota, and Wisconsin) and Alabama, the bulk of the brown ore from the Appalachian States, and the magnetite from New York, New Jersey, and Pennsylvania. All the iron carbonate is obtained from Ohio. On a later page is given the production of the principal ranges in the Lake Superior district. In the report for 1909 the production was given for the first time of two important southern mining centers, the Birmingham and the Chattanooga districts. In the Birmingham district are included, besides the mines in the immediate vicinity of Birmingham, those in eastern Alabama that ship ores to the furnaces at Birmingham. In the Chattanooga district are included those mines that ship ores to Chattanooga, Dayton, and Rockwood, Tenn., to Rome, Ga., and to Anniston, Ironaton, Rockrun, Gadsden, Alabama City, and Attalla, Ala. The brown-ore mines near Russellville, Ala., and in west-central Tennessee are not included in either district.

TOTAL PRODUCTION OF IRON ORE.

In the following table is shown the production of various types of iron ore in the United States as far as has been recorded. The statistics from 1889 to the present were collected by the United States Geological Survey; those for 1860, 1870, and 1880 were collected for the census reports of those years; those for 1875 and 1881 were estimated by I. L. Bell;[1] and those from 1882 to 1888, inclusive, were estimated by James M. Swank[2] from the pig-iron production. No figures can be obtained for the production of various classes of iron ores prior to 1889, except for the census year 1880.

Iron ore mined in the United States, 1860–1912, in long tons.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
1860					2,873,460
1870					[a] 3,831,891
1875					4,017,857
1880	2,243,993	1,918,622	2,134,276	823,471	7,120,362
1881					7,119,643
1882					[b] 8,700,000
1883					[b] 8,800,000
1884					[b] 7,718,129
1885					[b] 7,600,000
1886					[b] 10,000,000
1887					[b] 11,300,000
1888					[b] 12,062,530
1889	9,056,288	2,523,087	2,506,415	432,251	14,518,041
1890	10,527,650	2,559,938	2,570,838	377,617	16,036,043
1891	9,327,398	2,757,564	2,317,108	189,108	14,591,178
1892	11,646,619	2,485,101	1,971,965	192,981	16,296,666
1893	8,272,637	1,849,272	1,330,886	134,834	11,587,629
1894	9,347,434	1,472,748	972,219	87,278	11,879,679
1895	12,513,995	2,102,358	1,268,222	73,039	15,957,614
1896	12,576,288	2,126,212	1,211,526	91,423	16,005,449
1897	14,413,318	1,961,954	1,059,479	83,295	17,518,046
1898	16,150,684	1,989,681	1,237,978	55,373	19,433,716
1899	20,004,399	2,869,785	1,727,430	81,559	24,683,173
1900	22,708,274	3,231,089	1,537,551	76,247	27,553,161
1901	24,006,025	3,016,715	1,813,076	51,663	28,887,479
1902	30,532,149	3,305,484	1,688,860	27,642	35,554,135
1903	30,328,654	3,080,399	1,575,422	34,833	35,019,308
1904	23,839,477	2,146,795	1,638,846	19,212	27,644,330
1905	37,567,055	2,546,662	2,390,417	21,999	42,526,133
1906	42,481,375	2,781,063	2,469,294	17,996	47,749,728
1907	46,060,486	2,957,477	2,679,067	23,589	51,720,619
1908	31,788,564	[c] 2,620,390	[c] 1,547,797	26,585	35,983,336
1909	46,208,640	[c] 2,839,265	[c] 2,229,839	16,527	51,294,271
1910	51,367,007	[c] 2,993,744	[c] 2,631,835	22,320	[d] 57,014,906
1911	39,626,224	2,032,094	2,202,527	15,707	[d] 43,876,552
1912	51,345,782	1,614,486	2,179,533	10,346	[d] 55,150,147

[a] Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.
[b] Figures given are for consumption of domestic ores. Total production for 1882, 1883, and 1884 is estimated as 9,000,000, 8,400,000, and 8,200,000 tons, respectively. See Mineral Resources U. S. for 1883 and 1884.
[c] Some brown ore included in magnetite.
[d] In 1910, 1911, and 1912 ore sold for paint excluded from iron-ore production and included in metallic paint.

In the following table the production of iron ore in the United States is shown from 1810 to 1869, and by decades from 1870 to 1909. The figures for the years previous to 1889 were calculated from the pig-iron production which included imported ore as well as domestic ore used.

[1] Bell, I. L., Principles of the manufacture of iron and steel, 1884, p. 451.
[2] Mineral Resources U. S., 1882 to 1888.

Production of iron ore in the United States from 1810 to 1909, by decades, and rate of increase.

Decade.	Quantity in long tons.	Percentage of increase.	Decade	Quantity in long tons.	Percentage of increase.
1810–1869	49,656,000	.....	1890–1899	163,989,193	80.1
1870–1879	44,570,527	.....	1900–1909	383,932,500	134.1
1880–1889	91,043,854	104.3			

PRINCIPAL IRON-ORE MINES.

In 1912, 382 iron-ore mines were active as compared with 374 mines in 1911, and 170 mines produced more than 50,000 long tons of iron ore each, as compared with 159 mines in 1911. The largest quantity produced by any single mine in 1912 was 2,633,285 long tons of hematite, mined at the Leonard mine, near Chisholm, on the Mesabi range, Minnesota. The Hill mine at Marble, Minn., also on the Mesabi range, held the record in 1911 with an output of 1,553,510 long tons, but the output of this mine was decreased considerably in 1912 so that it ranked eighth as a producer. Nine mines in Minnesota besides one group in Alabama produced more than 1,000,000 tons each, as compared with six mines in Minnesota and one group in Alabama in 1911. The second largest producer in 1912 was the Hull-Rust mine at Hibbing, Minn., on the Mesabi range, which mined 2,232,180 long tons of hematite. The Hull-Rust during several former years occupied first place. The largest producer in Michigan in 1912 was the Norrie group, which reported having mined 994,512 long tons of hematite. Permission has been granted to the Survey by the owners and operators of 146 of these large mines to publish their production, and these statistics are given in the following table:

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1912.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity.
1	Leonard	Minnesota	Chisholm	Hematite	2,633,285
2	Hull-Rust	do	Hibbing	do	2,232,180
3	Canisteo	do	Coleraine	do	2,097,406
4	Red Mountain group	Alabama	Bessemer	do	1,889,366
5	Uno	Minnesota	Hibbing	do	1,858,973
6	Genoa	do	Gilbert	do	1,624,502
7	Mahoning	do	Hibbing	do	1,518,644
8	Hill	do	Marble	do	1,186,252
9	Sauntry-Alpena	do	Virginia	do	1,107,857
10	Dale	do	Hibbing	do	1,107,776
11	Norrie group	Michigan	Ironwood	do	994,512
12	Adams	Minnesota	Eveleth	do	980,181
13	Holman	do	Taconite	do	918,969
14	Newport	Michigan	Ironwood	do	813,016
15	Shenango	Minnesota	Chisholm	do	797,221
16	Hawkins	do	Nashwauk	do	679,154
17	Stevenson	do	Hibbing	do	676,073
18	Spruce	do	Eveleth	do	672,174
19	Chisholm	do	Chisholm	do	649,812
20	Commodore	do	Virginia	do	567,055
21	Kinney	do	Kinney	do	530,080
22	Virginia group	do	Virginia	do	529,207
23	Witherbee, Sherman & Co. (Inc.)	New York	Mineville	Magnetite	508,729
24	Susquehanna	Minnesota	Hibbing	Hematite	494,898
25	Clark	do	Chisholm	do	478,256
26	Cornwall	Pennsylvania	Miners Village	Magnetite	473,095
27	Zenith	Minnesota	Ely	Hematite	472,513
28	Woodward 1, 2, and 3	Alabama	Lipscomb	do	471,264
29	Pioneer	Minnesota	Ely	do	456,033
30	Mississippi	do	Keewatin	do	451,932

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1912—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity.
31	Penn	Michigan	Norway and Vulcan.	Hematite	451,519
32	Fayal	Minnesota	Eveleth	do	428,360
33	Bristol	Michigan	Crystal Falls	do	409,685
34	Grant	Minnesota	Buhl	do	399,848
35	Sliver	do	Virginia	do	390,589
36	Leetonia	do	Hibbing	do	360,854
37	Tobin (including Genesee)	Michigan	Crystal Falls	do	332,669
38	Chapin	do	Iron Mountain	do	329,199
39	Harold	Minnesota	Hibbing	do	315,586
40	Queen group	Michigan	Negaunee	do	314,438
41	Biwabik	Minnesota	Biwabik	do	310,000
42	Caspian	Michigan	Palatka	do	302,244
43	Miller	Minnesota	Aurora	do	289,179
44	Pewabic	Michigan	Iron Mountain	do	286,298
45	Mary Charlotte, Nos. 1 and 2	do	Negaunee	do	277,054
46	Colby	do	Bessemer	do	266,553
47	Cliff shaft	do	Ishpeming	do	261,320
48	Albany	Minnesota	Hibbing	do	245,554
49	Monroe-Tener	do	Chisholm	do	237,700
50	Cary	Wisconsin	Hurley	do	236,467
51	Whiteside	Minnesota	Buhl	do	232,979
52	Hudson	do	Aurora	do	230,831
53	Laura	do	Hibbing	do	225,780
54	Utica	do	do	do	224,125
55	Schley	do	Gilbert	do	222,849
56	Aurora	Michigan	Ironwood	do	221,598
57	Raimund No. 1	Alabama	Bessemer	do	217,503
58	Aragon	Michigan	Norway	do	215,412
59	Brunt	Minnesota	Mountain Iron	do	213,754
60	Scranton	do	Hibbing	do	211,980
61	Baltic (including Fogarty)	Michigan	Palatka	do	209,937
62	Sibley	Minnesota	Ely	do	206,914
63	Union	do	Virginia	do	206,513
64	Kennedy	do	Cuyuna	do	205,363
65	Hanna	do	Mountain Iron	do	205,102
66	Virginia	do	Eveleth	do	200,182
67	Dunn	Michigan	Crystal Falls	do	198,927
68	Lake Superior	do	Ishpeming	do	191,832
69	Zimmerman	do	Palatka	do	190,047
70	Corsica	Minnesota	Gilbert	do	187,561
71	Songo	Alabama	Songo	do	173,578
72	Montreal	Wisconsin	Hurley	do	171,170
73	Lincoln	Minnesota	Virginia	do	170,723
74	Webb	do	Hibbing	do	169,881
75	Hiawatha	Michigan	Iron River	do	166,676
76	Port Henry No. 21	New York	Mineville	Magnetite	166,399
77	Bray	Minnesota	Keewatin	Hematite	164,732
78	Cardiff	Tennessee	Cardiff	do	164,355
79	American-Boston	Michigan	Diorite	do	164,207
80	Raimund No. 2	Alabama	Bessemer	do	159,043
81	La Rue	Minnesota	Nashwauk	do	157,490
82	Pettit	do	Gilbert	do	155,176
83	Riverton Group	Michigan	Iron River	do	153,793
84	Elba	Minnesota	Gilbert	do	151,525
85	Ironton	Michigan	Bessemer	do	149,210
86	Republic	do	Republic	do	142,322
87	Chicagon	do	Iron River	do	142,229
88	Lake Angeline	do	Ishpeming	do	141,904
89	Greeley	Alabama	Greeley	Brown ore	141,577
90	Mohawk	Minnesota	Aurora	Hematite	138,392
91	Mace	do	Hibbing	do	135,849
92	Tilden	Michigan	Bessemer	do	134,328
93	Steinman	Alabama	Steinman	do	126,695
94	Fowler	Minnesota	Aurora	do	124,716
95	Sunday Lake	Michigan	Wakefield	do	123,949
96	Crudup	Alabama	Gadsden	do	122,651
97	Hemlock	Michigan	Amasa	do	121,514
98	Chatham	do	Iron River	do	120,287
99	Richmond	do	Palmer	do	117,873
100	Wacoutah	Minnesota	Mountain Iron	do	117,304
101	Bangor	do	Biwabik	do	114,701
102	Florence	Wisconsin	Florence	do	110,968
103	Ottawa	do	Hurley	do	110,889
104	Rolling Mill	Michigan	Negaunee	do	110,289
105	Brotherton	do	Wakefield	do	102,462
106	Gilbert	Minnesota	Gilbert	do	101,913
107	Agnew	do	Hibbing	do	101,600
108	Mansfield	Michigan	Crystal Falls	do	99,830
109	Davidson No. 2	do	Iron River	do	98,859
110	Mayville	Wisconsin	Mayville	do	94,796

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1912—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity.
111	Ironaton	Alabama	Ironaton	Brown ore	93,980
112	Cyprus	Minnesota	Hibbing	Hematite	93,795
113	Adriatic	do	Mesaba	do	93,791
114	Croxton	do	Chisholm	do	91,574
115	Youngs	Michigan	Iron River	do	90,838
116	Kellogg	Minnesota	Biwabik	do	89,845
117	Castile	Michigan	Ramsay	do	89,482
118	Myers	Minnesota	Chisholm	do	87,670
119	Savoy	do	Ely	do	86,992
120	Monica	do	Biwabik	do	85,833
121	Loretto	Michigan	Loretto	do	85,322
122	Soudan	Minnesota	Soudan	do	79,211
123	Osana	Michigan	Iron River	do	78,812
124	Section 30	Minnesota	Ely	do	78,110
125	Richard	New Jersey	Wharton	Magnetite	77,198
126	Docray	Alabama	Docray	Brown ore	77,169
127	Pearson	Minnesota	Nashwauk	Hematite	75,969
128	Armour No. 2	do	Crosby	do	73,089
129	Yale	Michigan	Bessemer	do	72,533
130	Chandler	Minnesota	Ely	do	72,500
131	Atlantic	Wisconsin	Iron Belt	do	72,169
132	Armenia	Michigan	Crystal Falls	do	71,165
133	Winifred	Minnesota	Hibbing	do	70,955
134	Breitung Hematite No. 2	Michigan	Negaunee	do	70,063
135	Houston	Alabama	Rickey	Brown ore	68,763
136	Barron	Michigan	Humboldt	Hematite	68,725
137	Cranberry	North Carolina	Cranberry	Magnetite	68,322
138	Woodbridge	Minnesota	Buhl	Hematite	68,083
139	Armour No. 1	do	Crosby	do	66,526
140	Franklin	do	Virginia	do	66,434
141	Peters	New Jersey	Ringwood	Magnetite	65,135
142	Attalla	Alabama	Attalla	Hematite	63,604
143	Burt	Minnesota	Hibbing	do	61,648
144	Perkins	do	Aurora	do	60,523
145	Tannehill	Alabama	Goethite	Brown ore	55,512
146	Volunteer	do	Negaunee	do	52,838
	Total (146 mines)				48,694,753
	Unspecified (24 mines) [a]				3,702,225
	Tonnage from mines producing more than 50,000 long tons each				52,396,978
	Tonnage from mines producing less than 50,000 long tons each				2,753,169
	Grand total of United States				55,150,147

[a] Includes the product of 24 mines producing over 50,000 long tons each, operated by 11 companies, which do not permit the publication of individual statistics.

STOCKS OF IRON ORE AT MINES.

According to the reports of producers, many of which have been somewhat revised since the report for 1911 was published, the total quantity of iron ore in stock at the mines at the close of 1912 amounted to 10,241,287 long tons, compared with 12,206,390 tons at the close of 1911, a reduction of 1,965,103 tons, or 16.1 per cent, which balances closely with the excess of sales over quantity mined.

Since the tonnage of ore in stock piles is necessarily partly estimated, there are variations in the mine reports from year to year which prevent an absolutely accurate balance between the quantity mined and the quantity sold and stocks on hand. It is believed, however, as stated in the introduction, that the figures presented in this report covering the years 1911 and 1912 are much more nearly accurate than for any previous years.

The following table shows the tonnage of unsold iron ore in stock at the mines on December 31, 1911 and 1912, in the various States. Besides this stock at the mines, stocks are left at receiving ports and at blast furnaces, but these are included in the total ore marketed.

Stock of iron ore on hand at the mines unsold Dec. 31, 1911 and 1912, by States, in long tons.

State.	1911	1912	State.	1911	1912
Alabama	588,549	373,440	Pennsylvania	34,416	33,118
Georgia	700	.....	Tennessee	8,955	9,787
Maryland	4,000	4,200	Texas	24,600	25,600
Massachusetts	5,461	1,013	Utah	5,425	230
Michigan	6,082,501	4,462,841	Virginia	14,500	61,730
Minnesota	4,732,976	4,912,598	West Virginia	15,000	15,000
Mississippi	50	50	Wisconsin	425,163	132,659
Missouri	1,140	1,720			
New Jersey	124,080	122,646	Total	12,206,390	10,241,287
New York	122,434	78,200	Percentage of decrease in 1912	.....	16.10
Ohio	16,440	6,455			

PRICE OF IRON ORE PER TON.

In the following table the price per ton of the different classes of iron ore in 1911 and 1912 is given for each of the producing States or groups of States. The total average prices per long ton (considering the whole United States) in 1912 were: Hematite, $1.87; brown ore, $1.79; magnetite, $2.18; carbonate, $1.96; as compared with prices, respectively, of $2.12, $1.72, $2.29, and $1.83 in 1911. These figures represent the value at the mines and are taken directly from statements of the producers. They are probably only approximately correct. The element of inaccuracy arises from the fact that by far the greater bulk of the iron ore produced in the United States is mined by pig iron producers for their own furnaces, and the value placed on such ore is therefore largely a matter of accounting. Some of the reports made to the Survey evidently include merely actual mining costs; others contain an allowance for sinking fund; and in still others the figures given are prices used in charging costs against the blast furnaces.

The general average price of all kinds of iron ore in the United States was $1.88 in 1912, compared with $2.11 in 1911, a decrease of 23 cents a ton, or 10.9 per cent. It is of interest to compare the prices given below with those of the Lake Superior ores at the lower Lake ports given in a subsequent table. If the freight rates by rail from the mines to Duluth, Superior, Marquette, and Escanaba, plus the freight rates by water, are deducted from prices at lower Lake ports, the margin of profit appears small.

Average price per long ton of iron ore marketed in the United States in 1911 and 1912, by States and varieties.

State.	Hematite.		Brown ore.		Magnetite.		Carbonate.	
	1911	1912	1911	1912	1911	1912	1911	1912
Alabama	$1.17	$1.16	$1.47	$1.43				
Georgia	1.38	(a)	1.54	a 1.68				
Michigan	2.66	2.27						
Minnesota	2.07	1.80						
Missouri	2.17	2.21	1.83	2.16				
New Jersey			3.70		$3.22	$3.25		
New York	2.05	1.92			2.82	2.57		
Ohio							$1.83	$1.96
Pennsylvania	1.87	2.33	2.37	2.46	.88	.79		
Tennessee	1.26	1.27	1.45	1.47				
Utah			3.57	3.10				
Virginia	1.58	1.62	1.91	2.26	1.50			
Wisconsin	2.48	2.37						
Other States b	1.03	1.01	2.39	2.83	1.28	1.52		
Total average	2.12	1.87	1.72	1.79	2.29	2.18	1.83	1.96

a Hematite included in brown ore.

b 1911: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Mississippi, Montana, Nevada, New Mexico, North Carolina, West Virginia, and Wyoming; 1912: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Montana, Nevada, New Mexico, North Carolina Texas, West Virginia, and Wyoming.

APPARENT ANNUAL IRON-ORE CONSUMPTION.

The following table includes data on certain items from which an approximate estimate of the annual consumption of iron ore in the United States is deduced. The result is, of course, merely an approximation, for no data are available on certain other items which should enter into the final result. The items considered in the table and estimates for all years except 1911 and 1912 are (1) domestic iron-ore production; (2) stocks of ore at mines for current year and past year; (3) stocks of ore at lower Lake ports for current year and past year; (4) zinc residuum production; (5) imports of ore; (6) exports of ore. In 1911 and 1912 the sales of ore, zinc residuum, and the imports constitute the available supply, which, less the exports gives the apparent consumption.

Apparent consumption of iron ore in the United States, 1889–1912, in long tons.

Year.	Domestic iron ore produced.[a]	Stocks of ore at mines.	Stocks of ore at lower Lake ports Dec. 1.	Zinc residuum.	Imports.	Exports.	Apparent consumption.
1889	14,518,041	2,256,973	2,607,106	43,648	853,573	.....	14,366,562
1890	16,036,043	2,000,000	3,893,487	48,560	1,246,830	.....	16,302,025
1891	14,591,178	2,450,279	3,508,489	38,228	912,864	.....	15,476,989
1892	16,296,666	2,911,740	4,149,451	31,859	806,585	.....	16,032,687
1893	11,587,629	3,526,161	4,070,710	37,512	526,951	.....	11,616,412
1894	11,879,679	3,236,198	4,834,247	26,981	167,307	.....	11,600,393
1895	15,957,614	2,976,494	4,415,712	43,249	524,153	.....	17,203,255
1896	16,005,449	3,405,302	4,954,984	44,953	682,806	.....	15,765,128
1897	17,518,046	3,098,287	5,923,755	33,924	489,970	.....	17,380,184
1898	19,433,716	2,846,457	5,136,407	48,502	187,208	.....	20,708,604
1899	24,683,173	2,320,278	5,530,283	65,010	674,082	40,665	25,513,903
1900	27,553,161	3,709,950	5,904,670	87,110	897,831	51,460	26,722,583
1901	28,887,479	4,239,823	5,859,663	52,311	966,950	64,703	29,357,171
1902	35,554,135	3,834,717	7,074,254	65,246	1,165,470	88,445	35,886,921
1903	35,019,308	6,297,888	6,371,085	73,264	980,440	80,611	34,232,399
1904	27,644,330	4,666,931	5,763,399	68,189	487,613	213,865	30,224,910
1905	42,526,133	3,812,281	6,438,967	90,289	845,651	208,017	43,433,138
1906	47,749,728	3,281,789	6,252,455	93,461	1,060,390	265,240	49,355,343
1907	51,720,619	3,033,110	7,385,728	93,413	1,229,168	278,608	51,879,998
1908	35,983,336	6,065,397	8,441,533	110,225	776,898	309,099	32,473,268
1909	51,294,271	6,135,271	8,965,789	141,264	1,694,957	455,934	52,080,428
1910	57,014,906	9,422,285	9,426,881	137,173	2,591,031	748,875	55,246,129
1911	41,092,447	.....	.....	109,296	1,811,732	768,386	42,245,089
1912	57,017,614	.....	.....	104,670	2,104,576	1,195,742	58,031,118

[a] Iron ore sold for paint excluded from 1910, 1911, and 1912 production and included in metallic paint. In 1911 and 1912 figures represent sales.

COMPARATIVE PRODUCTION OF IRON ORE AND PIG IRON.

Detailed data on the pig-iron production of the United States are presented on later pages of this report, but in the following table an interesting comparison is made between the annual production of iron ore and pig iron:

Production of iron ore and pig iron in the United States, 1889–1912, in long tons.

Year.	Iron ore produced.[a]	Pig iron produced.[b]	Percentage ratio of pig iron to iron ore.	Year.	Iron ore produced.[a]	Pig iron produced.[b]	Percentage ratio of pig iron to iron ore.
1889	14,518,041	7,603,642	52.4	1901	28,887,479	15,878,354	54.9
1890	16,036,043	9,202,703	57.4	1902	35,554,135	17,821,307	50.1
1891	14,591,178	8,279,870	56.7	1903	35,019,308	18,009,252	51.4
1892	16,296,666	9,157,000	56.2	1904	27,644,330	16,497,033	59.7
1893	11,587,629	7,124,502	61.5	1905	42,526,133	22,992,380	54.0
1894	11,879,679	6,657,388	56.0	1906	47,749,728	25,307,191	53.0
1895	15,957,614	9,446,308	59.2	1907	51,720,619	25,781,361	49.8
1896	16,005,449	8,623,127	53.8	1908	35,983,336	15,936,018	44.3
1897	17,518,046	9,652,680	55.1	1909	51,294,271	25,795,471	50.3
1898	19,433,716	11,773,934	60.6	1910	57,014,906	27,303,567	47.9
1899	24,683,173	13,620,703	55.2	1911	43,876,552	23,649,547	53.9
1900	27,553,161	13,789,242	50.0	1912	55,150,147	29,726,937	53.9

[a] Iron ore sold for paint excluded from 1910, 1911, and 1912 production and included in metallic paint. Iron ore statistics collected by United States Geological Survey.

[b] From annual reports of the American Iron and Steel Association prior to 1912, and including ferroalloys produced in blast furnaces. Statistics for 1912, according to American Iron and Steel Institute, and also including ferroalloys.

IRON-ORE INDUSTRY IN THE LAKE SUPERIOR DISTRICT.

Production of iron ore in the Lake Superior district, by ranges.—The Lake Superior district includes the Vermilion, Mesabi, Cuyuna, Penokee-Gogebic, Marquette, and Menominee ranges in the States of Minnesota, Michigan, and Wisconsin. The Menominee range includes the Crystal Falls, Metropolitan, Iron River, and Florence areas; the Marquette range includes the Republic and Swanzy areas. The Baraboo and Iron Ridge areas of southern Wisconsin and the

Spring Valley area of northwestern Wisconsin are frequently also included in the Lake Superior district. In the first group of ranges the ore mined is almost entirely Algonkian hematite, belonging to the Huronian series. The Baraboo ore is of the same nature, but the Iron Ridge ore is "Clinton" hematite, and the Spring Valley ore is brown ore.

In addition to these ranges there are several iron-ore districts on the Canadian side of the Great Lakes, the principal ones of which are the Michipicoten, the Animikie, the Matawin, and the Atikokan.

The ranges in the United States which produced ore in 1912 were the Vermilion, Mesabi, Penokee-Gogebic, Marquette, Menominee, and Cuyuna, besides the Baraboo and Iron Ridge areas. Much development work was done on the Cuyuna range, which made its first shipments in 1911.

An analysis of reported production (quantity mined) in 1912, by ranges, in the Lake Superior district, shows that the Mesabi range mined 32,604,756 tons of iron ore, compared with 23,126,943 tons in 1911, an increase of 40.98 per cent; the Menominee range 4,465,466 tons, compared with 4,062,778 tons in 1911, an increase of 9.91 per cent; the Gogebic range 3,926,632 tons, compared with 3,099,197 tons in 1911, an increase of 26.7 per cent; the Marquette range 3,545,012 tons, compared with 3,743,145 tons in 1911, a decrease of 5.29 per cent; the Vermilion range 1,457,273 tons, compared with 1,336,938 tons in 1911, an increase of 9 per cent; and the Cuyuna range, which in 1912 entered upon its second year as a shipper of ore, 369,739 tons, compared with 181,224 tons in 1911, an increase of 104.02 per cent.

The Mesabi range produced 70.32 per cent of the entire Lake Superior output and more than 59 per cent of the entire production of the United States. The Menominee, Penokee-Gogebic, and Marquette ranges are next in importance, the Menominee producing in 1912 a little less than the State of Alabama, which is the next State in importance as a producer after Minnesota and Michigan. The Vermilion range, the fifth in importance of the six producing Lake Superior ranges, produced more ore in 1912 than New York, which is fourth in importance as a producing State.

The following table shows the production of the first six of these ranges for 1911 and 1912, as they constitute the Lake Superior district proper:

Production of iron ore (quantity mined) in the Lake Superior region,[a] 1911–1912, by ranges, in long tons.

Range.	1911	1912	Increase (+) or decrease (−) in 1912.	Percentage of increase (+) or decrease(−) in 1912.	Percentage of total production in Lake Superior region, 1912.
Marquette (Michigan)	3,743,145	3,545,012	− 198,133	− 5.29	7.64
Menominee (Michigan and Wisconsin)	4,062,778	4,465,466	+ 402,688	+ 9.91	9.63
Gogebic (Michigan and Wisconsin)	3,099,197	3,926,632	+ 827,435	+ 26.70	8.47
Vermilion (Minnesota)	1,336,938	1,457,273	+ 120,335	+ 9.00	3.14
Mesabi (Minnesota)	23,126,943	32,604,756	+ 9,477,813	+ 40.98	70.32
Cuyuna (Minnesota)	181,224	369,739	+ 188,515	+104.02	.80
Total	35,550,225	46,368,878	+10,818,653	+ 30.43	100.00

[a] Includes only such Wisconsin mines as are in the true Lake Superior district.

In the following table is shown the total production of the Lake Superior district by ranges. The figures prior to 1872 were collected by A. P. Swineford, editor Marquette Mining Journal;[1] those for 1872 to 1877, inclusive, are from the Michigan Mineral Statistics; those from 1878 to 1888, inclusive, were collected by W. J. Stevens;[2] and the later figures were collected by the United States Geological Survey.

Production of Lake Superior iron ore, 1854–1912, by ranges, in long tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Cuyuna.	Total.
1854–1869	3,112,209						3,112,209
1870	859,507						859,507
1871	813,984						813,984
1872	948,553						948,553
1873	1,195,234						1,195,234
1874	899,934						899,934
1875	881,166						881,166
1876	993,311						993,311
1877	1,014,754	10,375					1,025,129
1878	1,033,082	78,028					1,111,110
1879	1,130,019	245,672					1,375,691
1880	1,384,010	524,735					1,908,745
1881	1,579,834	726,671					2,306,505
1882	1,829,394	1,136,018					2,965,412
1883	1,305,364	1,047,863					2,353,227
1884	1,559,912	895,634	1,022	62,122			2,518,690
1885	1,430,862	690,435	119,590	227,075			2,467,962
1886	1,627,383	880,006	756,237	307,948			3,571,574
1887	1,851,717	1,199,343	1,285,265	394,910			4,731,235
1888	1,918,672	1,191,097	1,433,689	511,953			5,055,411
1889	2,631,026	1,876,157	2,147,923	864,508			7,519,614
1890	2,863,848	2,274,192	2,914,081	891,910			8,944,031
1891	2,778,482	1,856,124	2,041,754	945,105			7,621,465
1892	2,848,552	2,402,195	3,058,176	1,226,220	29,245		9,564,388
1893	2,064,827	1,563,049	1,466,815	815,735	684,194		6,594,620
1894	1,935,379	1,255,255	1,523,451	1,055,229	1,913,234		7,682,548
1895	1,982,080	1,794,970	2,625,475	1,027,103	2,839,350		10,268,978
1896	2,418,846	1,763,235	2,100,398	1,200,907	3,082,973		10,566,359
1897	2,673,785	1,767,220	2,163,088	1,381,278	4,220,151		12,205,522
1898	2,987,930	2,275,664	2,552,205	1,125,538	4,837,971		13,779,308
1899	3,634,596	3,281,422	2,725,648	1,643,984	6,517,305		17,802,955
1900	3,945,068	3,680,738	3,104,033	1,675,949	8,158,450		20,564,238
1901	3,597,089	3,697,408	3,041,869	1,805,996	9,303,541		21,445,903
1902	3,734,712	4,421,250	3,683,792	2,057,532	13,080,118		26,977,404
1903	3,686,214	4,093,320	3,422,341	1,918,584	13,452,812		26,573,271
1904	2,465,448	2,871,130	2,132,898	1,056,430	11,672,405		20,198,311
1905	3,772,645	4,472,630	3,344,551	1,578,626	20,156,566		33,325,018
1906	4,070,914	4,962,357	3,484,023	1,794,186	23,564,891		37,876,371
1907	4,167,810	4,779,592	3,609,519	1,724,217	27,245,411		41,526,579
1908	3,309,917	2,904,011	3,241,931	927,206	17,725,014		28,108,079
1909	4,291,967	4,789,362	3,807,157	1,097,444	27,877,705		41,863,635
1900	4,631,427	4,983,729	4,746,818	1,390,360	30,576,409		46,328,743
1911	3,743,145	4,062,778	3,099,197	1,336,938	23,126,943	181,224	35,550,225
1912	3,545,012	4,465,466	3,926,632	1,457,273	32,604,756	369,739	46,368,878
Total	105,149,620	84,919,131	73,559,578	33,502,266	282,669,474	550,963	580,351,032

Shipments and receipts of Lake Superior ore.—According to the Iron Trade Review 48,221,546 long tons of iron ore were shipped from the Lake Superior district, compared with 32,793,130 tons in 1911. Of the 1912 total 785,769 tons were shipped by rail, the remainder being by boat; in 1911, 662,719 tons were shipped by rail.

The marketed production of the Lake Superior iron ore ranges as reported to the Survey in 1912 amounted to 48,199,531 long tons. This quantity agrees within 0.05 per cent with the tonnage published by the Iron Trade Review.

[1] Mineral Resources U. S. for 1882 116.

[2] Mineral Resources U. S. for 1891, p. 41.

The following tables give the details of shipments and receipts of Lake Superior iron ore by ports:

Shipments of Lake Superior iron ore, 1907–1912, in long tons.[a]

Shipping port.	1907	1908	1909	1910	1911	1912
Escanaba, Mich	5,761,988	3,351,502	5,747,801	4,959,726	4,278,445	5,234,655
Marquette, Mich	3,013,826	1,487,487	2,909,451	3,248,516	2,200,380	3,296,761
Ashland, Wis	3,436,867	2,513,670	3,834,207	4,094,374	2,429,290	4,797,101
Two Harbors, Minn	8,188,906	5,702,237	9,181,132	8,271,177	6,367,537	9,370,969
Superior, Wis	7,440,386	3,564,030	6,540,505	*8,414,799	9,920,490	14,240,714
Duluth, Minn	13,448,736	8,808,168	13,470,503	13,640,166	6,934,269	10,495,577
Total by Lake	41,290,709	25,427,094	41,683,599	42,628,758	32,130,411	47,435,777
Total by rail	975,959	587,893	903,270	813,639	662,719	785,769
Total	42,266,668	26,014,987	42,586,869	43,442,397	32,793,130	48,221,546

[a] Iron Trade Review.

Iron-ore receipts at Lake Erie ports, 1907–1912, in long tons.[a]

Port.	1907	1908	1909	1910	1911	1912
Toledo	1,314,140	680,553	1,374,224	1,225,202	493,345	1,405,023
Sandusky	83,043	.....	11,088	.....	.....	.....
Huron	971,430	213,377	243,082	197,951	223,947	540,586
Lorain	2,621,025	2,286,388	2,796,856	2,884,738	2,937,605	3,771,350
Cleveland	6,495,998	4,240,816	6,051,342	6,344,943	4,584,211	7,914,836
Fairport	2,437,649	1,518,961	1,734,277	1,516,434	666,365	1,810,381
Ashtabula	7,521,859	3,012,064	8,056,941	9,620,638	6,359,131	8,158,080
Conneaut	5,875,937	4,798,631	7,007,834	6,309,548	6,931,278	7,839,831
Erie	2,294,239	828,602	1,235,057	942,592	289,400	547,067
Buffalo	5,580,438	2,835,099	5,002,235	4,704,439	2,802,976	5,060,642
Detroit	153,157	112,561	159,889	296,412	243,292	418,057
Total	35,348,915	20,527,052	33,672,825	34,042,897	25,531,550	37,465,853

[a] Trade Iron Review.

The difference between the shipments of Lake Superior ore and the receipts at Lake Erie ports is accounted for mainly by the quantity of ore delivered at Lake Michigan ports, South Chicago, Ill., Gary and Indiana Harbor, Ind., and Milwaukee, Wis., the receipts at which ports and at a number of smaller places are shown in the following table:

Iron-ore receipts at Lake Michigan ports, 1909–1912, in long tons.[a]

Port.	1909	1910	1911	1912
Elk Rapids, Mich	46,037	60,857	26,814	47,947
East Jordan, Mich	18,623	37,910	36,232	42,878
Milwaukee, Wis	178,720	121,446	109,255	138,065
Gary, Ind	1,921,813	1,775,880	1,302,745	2,088,327
Indiana Harbor, Ind	.....	287,172	365,312	514,748
South Chicago, Ill	4,673,818	5,080,679	3,685,100	5,480,105
Boyne City, Mich	37,062	50,355	33,000	45,000
Fruitport, Mich	53,761	37,785	.....	.....
Total	6,929,831	7,452,084	5,558,458	8,357,070

[a] Iron Trade Review.

The following table shows the total quantity of iron ore shipped from the Lake Superior district since 1854, the date of the opening of the Marquette range, the oldest of the Lake Superior ranges. This table gives the shipments as published by the Iron Trade Review and is inserted for comparison with the table giving the total production of the Lake Superior district, without regard to shipments:

Shipments of iron ore from the Lake Superior region, 1854–1912, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1854	3,000	1875	891,257	1896	9,934,828
1855	1,449	1876	992,764	1897	12,469,638
1856	36,343	1877	1,015,087	1898	14,024,673
1857	25,646	1878	1,111,110	1899	18,251,804
1858	15,876	1879	1,375,691	1900	19,059,393
1859	68,832	1880	1,908,745	1901	20,589,237
1860	114,401	1881	2,306,505	1902	27,571,121
1861	49,909	1882	2,965,412	1903	24,289,878
1862	124,169	1883	2,353,288	1904	21,822,839
1863	203,055	1884	2,518,692	1905	34,384,116
1864	243,127	1885	2,466,372	1906	38,565,762
1865	236,208	1886	3,568,022	1907	42,266,668
1866	278,796	1887	4,730,577	1908	26,014,987
1867	473,567	1888	5,063,693	1909	42,586,869
1868	491,449	1889	7,292,754	1910	43,442,397
1869	617,444	1890	9,012,379	1911	32,793,130
1870	830,940	1891	7,062,233	1912	48,221,546
1871	779,607	1892	9,069,556		
1872	900,901	1893	6,060,492	Total	573,808,218
1873	1,162,458	1894	7,748,932		
1874	919,557	1895	10,429,037		

Stocks of iron ore at Lake Erie ports.—The following tables contain data as to the stocks of iron ore at the Lake Erie ports at the close of navigation and at the opening of navigation for the last six years:

Stocks of iron ore at lower Lake ports, Dec. 1, 1907–1912, in long tons.[a]

Port.	At close of navigation, Dec. 1—					
	1907	1908	1909	1910	1911	1912
Toledo, Ohio	518,645	590,925	332,456	433,215	661,382	552,016
Sandusky, Ohio	44,546	36,079	39,557	17,728	2,471	2,472
Huron, Ohio	415,730	458,158	477,333	375,118	344,371	385,810
Lorain, Ohio	366,271	426,274	407,129	259,448	314,321	320,713
Cleveland, Ohio	1,281,335	1,458,392	1,547,142	1,638,795	1,589,491	1,888,560
Fairport, Ohio	523,981	835,821	867,640	839,970	636,566	565,920
Ashtabula, Ohio	2,056,820	2,293,531	2,594,359	3,287,816	3,295,862	3,350,553
Conneaut, Ohio	1,090,774	1,296,675	1,411,002	1,329,997	1,237,573	1,429,533
Erie, Pa	652,219	730,530	788,046	792,011	636,274	661,330
Buffalo, N. Y	435,407	315,148	501,125	452,783	413,353	340,261
Total	7,385,728	8,441,533	8,965,789	9,426,881	9,131,664	9,497,168

[a] Iron Trade Review.

Stocks of iron ore at lower Lake ports, May 1, 1908–1913, in long tons.[a]

Port.	At opening of navigation, May 1—					
	1908	1909	1910	1911	1912	1913
Toledo, Ohio	217,788	380,675	366,631	383,761	356,102	394,984
Sandusky, Ohio	42,256	31,528	22,468	11,458	2,471	2,485
Huron, Ohio	392,731	379,364	336,693	273,042	257,496	293,006
Lorain, Ohio	327,052	362,096	205,445	346,849	287,294	399,705
Cleveland, Ohio	1,029,198	1,018,055	985,725	1,476,278	1,363,696	1,428,306
Fairport, Ohio	225,328	562,679	541,299	633,485	381,705	357,995
Ashtabula, Ohio	1,799,454	1,392,430	1,444,102	2,255,066	2,108,749	2,105,817
Conneaut, Ohio	462,392	497,203	461,365	419,421	229,462	135,100
Erie, Pa	595,660	557,029	550,187	653,778	585,150	449,455
Buffalo, N. Y	388,441	189,209	364,336	325,356	309,120	139,624
Total	5,480,300	5,370,268	5,278,251	6,778,494	5,881,245	5,706,477

[a] Iron Trade Review.

Prices of Lake Superior iron ore.—In the following table are given the prices of Lake Superior iron ore at the lower Lake ports from 1890 to 1913, according to the Iron Trade Review.

The base for the Bessemer ore is a metallic iron content of 55 per cent; that of the non-Bessemer ore is a metallic iron content of 51.5 per cent:

Selling price of iron ore at lower Lake ports, 1890–1913, at date of buying movement.[a]

Season.	Date buying movement.	Season iron-ore prices.			
		Old range Bessemer.	Mesabi Bessemer.	Old range non-Bessemer.	Mesabi non-Bessemer.
1890	Dec. 15, 1889	$5.50	No sale.	$5.25	No sale.
1891	June 1, 1891	4.50	No sale.	4.25	No sale.
1892	Jan. 31, 1892	4.50	No sale.	3.65	No sale.
1893	Mar. 15, 1893	3.85	$3.00	3.20	No sale.
1894	Mar. 1, 1894	2.75	2.35	2.50	No sale.
1895	Apr. 1, 1895	2.90	2.15	2.25	$1.90
1896	May 1, 1896	4.00	3.50	2.70	2.25
1897	May 20, 1897	2.60	2.25	2.15	1.90
1898	Mar. 20, 1898	2.75	2.25	1.85	1.75
1899	Feb. 1, 1899	3.00	2.40	2.15	2.00
1900	Dec. 15, 1899	5.50	4.50	4.25	4.00
1901	Apr. 15, 1901	4.25	3.25	3.00	2.75
1902	Feb. 1, 1902	4.25	3.25	3.25	2.75
1903	Mar. 20, 1903	4.50	4.00	3.60	3.20
1904	Apr. 15, 1904	3.25	3.00	2.75	2.50
1905	Feb. 1, 1905	3.75	3.50	3.20	3.00
1906	Dec. 5, 1905	4.25	4.00	3.70	3.50
1907	Nov. 5, 1906	5.00	4.75	4.20	4.00
1908	June 15, 1908	4.50	4.25	3.70	3.50
1909	May 10, 1909	4.50	4.25	3.70	3.50
1910	Dec. 24, 1909	5.00	4.75	4.20	4.00
1911	Apr. 21, 1911	4.50	4.25	3.70	3.50
1912	Mar. 20, 1912	3.75	3.50	3.00	2.85
1913	Nov. 19, 1912	4.40	4.15	3.60	3.40

[a] Iron Trade Review.

FOREIGN TRADE IN IRON ORE.

IMPORTS.

The quantity of iron ore imported into the United States in 1912 was 2,104,576 long tons, valued at $6,499,690, or $3.09 a ton. This represents an increase in quantity of 292,844 tons (16.16 per cent) and in value of $1,087,054, as compared with the imports during 1911, which were 1,811,732 long tons, valued at $5,412,636, or $2.99 per ton. As to the source of the imports in 1912, Cuba produced approximately 66 per cent of the ore, Sweden 16 per cent, Newfoundland and Labrador 7 per cent, Canada 5 per cent, Spain 4.4 per cent, with minor quantities from Russia, Germany, United Kingdom, the Netherlands, and other countries.

The statistics of imports of iron ore are furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce, and the following table gives the imports from the various countries from 1909 to 1912:

Quantity and value of iron ore imported into the United States in the calendar years 1909–1912, by countries, in long tons.

Country.	1909		1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cuba	927,774	$2,681,028	1,451,096	$4,459,789	1,147,879	$3,218,485	1,398,593	$3,969,986
Spain	291,547	664,460	439,868	1,040,589	194,965	502,453	92,061	222,951
French Africa	37,208	67,515	15,471	36,791	4,443	13,068	.....	.....
Greece	19,080	21,782	39,060	71,951	13,200	18,888	.....	.....
Newfoundland and Labrador	224,395	330,056	209,006	343,892	174,853	286,997	145,355	217,087
United Kingdom	869	12,846	11,388	52,591	1,436	19,725	10,229	20,587
Germany	3	100	3	58	2	76	1,729	5,602
Netherlands	.....	.....	.....	.....	223	420	5	72
Canada	27,155	84,613	95,005	251,086	50,480	106,038	106,675	201,882
Belgium	3	179	158	644	.....	.....	.....	.....
Russia in Europe	32,010	62,418	12,570	48,279	.....	.....	3,916	16,709
Sweden	120,564	627,315	259,911	1,391,976	219,238	1,215,588	333,863	1,781,579
Other countries	14,349	26,766	57,495	134,579	5,013	30,898	12,150	63,235
Total	1,694,957	4,579,078	2,591,031	7,832,225	1,811,732	5,412,636	2,104,576	6,499,690

The following table shows the imports of iron ore into the United States from 1909 to 1912, by ports of entry:

Quantity and value of iron ore imported into the United States in the calendar years 1909–1912, by customs districts, in long tons.

Customs district.	1909		1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Baltimore	628,577	$1,838,762	1,137,916	$3,575,059	806,354	$2,305,042	840,488	$2,359,765
Boston	7	29	235	853	100	272	98	252
New York	47,285	93,277	78,556	213,282	11,263	32,077	826	3,191
Philadelphia	991,983	2,559,760	1,269,180	3,775,770	984,192	3,039,994	1,229,737	4,072,776
Chicago	.....	.....	7,679	22,610	.....	.....	.....	.....
Puget Sound	.....	.....	25,000	47,750	.....	.....	.....	.....
San Francisco	.....	.....	.....	.....	10	250	.....	.....
Buffalo Creek	141	489	4,200	4,473	2,730	5,255	283	1,367
Champlain	40	75	29	73	146	1,904	30	660
Cuyahoga	3,500	15,250	.....	.....	2,902	6,675	3,113	5,448
Detroit	25	777	306	765	23	105	.....	.....
Erie	4,000	16,700	.....	.....	.....	.....	.....	.....
Miami	18,106	46,106	63,966	172,824	.....	.....	28,958	50,677
Niagara	596	2,310	2,343	11,166	1,668	8,343	810	3,818
Oswegatchie	.....	.....	25	75	50	150	.....	.....
Vermont	455	2,054	137	1,509	47	188	206	606
St. Louis	.....	.....	.....	.....	70	1,034	.....	.....
Genesee	17	895	10	553	13	527	27	1,130
Other districts	225	2,594	1,449	5,463	2,164	10,820	.....	.....
Total	1,694,957	4,579,078	2,591,031	7,832,225	1,811,732	5,412,636	2,104,576	6,499,690

In the following table is shown the importation of iron ore into the United States as far as has been recorded. Iron ore was imported from Europe in large quantities for the first time in 1879, most of the ore prior to that date coming from Canada:

Imports of iron ore into the United States, 1872–1912, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1872	23,733	1885	390,786	1899	674,082
1873	45,981	1886	1,039,433	1900	897,831
1874	57,987	1887	1,194,301	1901	966,950
1875	56,655	1888	587,470	1902	1,165,470
1876	17,284	1889	853,573	1903	980,440
1877	30,669	1890	1,246,830	1904	487,613
1878	28,212	1891	912,864	1905	845,651
1879[a]	150,197	1892	806,585	1906	1,060,390
1879[b]	284,141	1893	526,951	1907	1,229,168
1880	493,408	1894	167,307	1908	776,898
1881	782,887	1895	524,153	1909	1,694,957
1882	589,655	1896	682,806	1910	2,591,031
1883	490,875	1897	489,970	1911	1,811,732
1884	487,820	1898	187,208	1912	2,104,576

[a] Fiscal years end. [b] Calendar years begin.

EXPORTS.

The quantity of iron ore exported from the United States in 1912 amounted to 1,195,742 long tons, valued at $3,537,289, or $2.96 per ton, as compared with 768,386 long tons, valued at $2,653,448, or $3.45 per ton, in 1911. This represents an increase in quantity of 427,356 long tons, or more than 55 per cent, and in value of $883,841, or more than 33 per cent.

In the following table is shown the exportation of iron ore from the United States, by customs districts, from 1909 to 1912. The data regarding exports are furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Quantity and value of iron ore exported from the United States in the calendar years 1909–1912, by customs districts, in long tons.

Customs district.	1909		1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York					10	$68		
Savannah			10	$75				
Norfolk and Portsmouth	3	$27			37	357	2	$18
Saluria					4,175	9,412		
Buffalo Creek	336	1,506	1,203	6,054	2,115	10,575		
Champlain	9,417	27,170	19,941	71,740	13,583	49,278	19,200	76,359
Duluth	129,231	471,088	187,042	650,654	75,232	265,360	165,420	579,586
Niagara	6,887	21,819	2,848	12,956	369	1,550	94	330
Superior	306,270	830,415	519,396	1,683,824	657,895	2,286,908	991,437	2,841,677
Puget Sound	3,790	13,300	18,435	48,861	14,970	29,940	19,570	39,125
Baltimore							1	4
North Dakota and South Dakota							18	190
Total	455,934	1,365,325	748,875	2,474,164	768,386	2,653,448	1,195,742	3,537,289

The quantity of iron ore exported from the United States, so far as recorded, is shown in the following table:

Exports of iron ore from the United States, 1899–1912, in long tons.

Year.	Quantity.	Year.	Quantity.
1899	40,665	1906	265,240
1900	51,460	1907	278,608
1901	64,703	1908	309,099
1902	88,445	1909	455,934
1903	80,611	1910	748,875
1904	213,865	1911	768,386
1905	208,017	1912	1,195,742

IRON-ORE INDUSTRY OF CUBA.

The iron ore shipped from Cuba in 1912 amounted to 1,397,797 long tons, compared with 1,163,714 long tons in 1911, an increase of 234,083 tons, or more than 20 per cent. The shipments in 1912 did not quite reach the record shipments of 1910, which were 1,462,498 long tons. The 1912 shipments consisted of 68 per cent of hematite, including a little magnetite, and 32 per cent of brown ore. Since this report for 1911 was issued, the Spanish-American Iron Co. has furnished separate figures for shipments from the Daiquiri and Mayari mines, thus making it possible to differentiate the shipments of brown ore from those of hematite. Slight revisions in the total shipments for the years 1898 to 1901, 1903, and 1907 to 1909 were also made, and these have been incorporated in the present report.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the Cuban iron-ore shipments are collected by the United States Geological Survey.

Shipments of iron ore from mines in the Province of Oriente (Santiago), Cuba, 1884–1912, in long tons.

Year.	Juragua Iron Co. (Ltd.) (hematite and magnetite).	Sigua Iron Co. (hematite).	Spanish-American Iron Co.		Cuban Steel Ore Co. (hematite).	Ponupo Manganese Co. El Cuero iron mines (hematite).	Total.
			Daiquiri mines (hematite).	Mayari mines (brown ore).			
1884	25,295	.....	.....	.....	.....	.....	25,295
1885	80,716	.....	.....	.....	.....	.....	80,716
1886	112,074	.....	.....	.....	.....	.....	112,074
1887	94,240	.....	.....	.....	.....	.....	94,240
1888	206,061	.....	.....	.....	.....	.....	206,061
1889	260,291	.....	.....	.....	.....	.....	260,291
1890	363,842	.....	.....	.....	.....	.....	363,842
1891	264,262	.....	.....	.....	.....	.....	264,262
1892	335,236	6,418	.....	.....	.....	.....	341,654
1893	337,155	14,020	.....	.....	.....	.....	351,175
1894	156,826	.....	.....	.....	.....	.....	156,826
1895	307,503	.....	74,991	.....	.....	.....	382,494
1896	298,885	.....	114,110	.....	.....	.....	412,995
1897	[a] 248,256	.....	[b] 206,029	.....	.....	.....	454,285
1898	83,696	.....	80,225	.....	.....	.....	163,921
1899	161,783	.....	211,442	.....	.....	.....	373,225
1900	154,871	.....	293,195	.....	.....	.....	448,066
1901	199,764	.....	[c] 334,974	.....	17,651	.....	552,389
1902	221,039	.....	455,105	.....	23,590	.....	699,734
1903	155,898	.....	467,629	.....	.....	.....	623,527
1904	31,162	.....	356,111	.....	.....	.....	387,273
1905	139,828	.....	421,331	.....	.....	.....	561,159
1906	133,379	.....	507,195	.....	.....	.....	640,574
1907	181,063	.....	469,111	.....	.....	.....	650,174
1908	366,580	.....	254,256	.....	.....	.....	620,836
1909	356,659	.....	519,752	.....	.....	59,721	936,132
1910	318,814	.....	670,976	307,700	.....	165.008	1,462,498
1911	355,132	.....	252,717	387,791	.....	168,074	1,163,714
1912	360,094	.....	463,533	446,176	.....	127,994	1,397,797

[a] Of this quantity, 5,932 tons were sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons were sent to foreign ports.
[c] Of this quantity, 12,691 tons were sent to foreign ports.

PRODUCTION OF IRON ORE IN PRINCIPAL COUNTRIES.

The latest available statistics of production of iron ore in the principal producing countries since 1909 are given in the accompanying table.

Figures for all foreign countries except Algeria, Belgium, Canada, Cuba, France, German Empire and Luxemburg, Italy, Spain, and Tunis are taken from Mines and Quarries, London. For the above-named countries, except Algeria, Cuba, and Tunis, the figures are taken from the official statistical reports published by the several governments. The figures for Algeria and Tunis are taken from the official statistical report of the French Government; the figures for Cuban shipments are collected by the United States Geological Survey; and the figures for the Philippine Islands are derived from the report of the Bureau of Mines, Manila, P. I.

In the original publication the statistics of many of the countries are given in metric tons, but these have for the sake of comparison been reduced to long tons.

Production of iron ore in principal countries, 1909–1912, in long tons.

Country.	1909	1910	1911	1912
North America:				
Canada [a]	239,324	231,623	187,807	156,250
Cuba [a]	936,132	1,462,498	1,163,714	1,397,797
Mexico	2		(b)	(b)
Newfoundland	1,004,050	1,108,762	(b)	(b)
United States	51,294,271	57,014,906	43,876,552	55,150,147
Europe:				
Austria-Hungary	4,503,768	4,592,572	(b)	(b)
Belgium	196,565	121,024	148,130	(b)
France	11,702,756	14,375,984	(b)	(b)
German Empire and Luxemburg	25,102,819	28,257,579	29,408,812	(b)
Greece	468,126	527,040	(b)	(b)
Italy	497,141	542,578	367,900	(b)
Norway	39,753	100,834	(b)	(b)
Portugal		3,307	(b)	(b)
Russia [c]	(b)	(b)	(b)	(b)
Spain	8,647,658	(b)	(b)	(b)
Sweden	3,824,862	5,465,234	(b)	(b)
United Kingdom	14,804,382	15,226,015	15,519,424	(b)
Asia:				
China	[d] 306,000	[e] 130,472	(b)	(b)
India	83,456	54,626	(b)	(b)
Japan [f]	(b)	(b)	(b)	(b)
Chosen (Korea)	90,569	104,627	(b)	(b)
Philippine Islands [g]	230	148	216	416
Africa:				
Algeria	876,969	1,048,228	(b)	(b)
Madagascar	(b)	(h)	(b)	(b)
Natal		50	(b)	(b)
Tunis	214,815	327,756	(b)	(b)
Australia	115,835	157,821	(b)	(b)

[a] Shipments.
[b] Statistics not yet available.
[c] Russia produced 2,581,121 long tons of pig iron in 1909, and 2,936,024 tons in 1910.
[d] Output of Tayeh mines.
[e] Exports.
[f] Japan produced 53,338 long tons of pig iron in 1909, and 66,131 tons in 1910.
[g] Estimated by Bureau of Science of Philippine Islands for 1909 to 1911 from castings produced, and by U. S. Geological Survey for 1912 on same basis.
[h] Nearly 8 tons of iron (metal) produced in 1910.

SURVEY INVESTIGATIONS OF IRON ORE.

Although the Survey investigations of the iron-ore resources of the United States in the last 10 years, or since the completion of the studies of the iron-ore ranges in the Lake Superior district, have not been extensive, some work has been in progress nearly every field season. Within the last year four reports have been published by the Survey on iron-ore deposits in such widely separated parts of the United States as California, Montana, Wisconsin, and the adjacent parts of Tennessee, Alabama, and Georgia.

IRON ORE IN THE EAGLE MOUNTAINS, CAL.

The first of these recent reports, issued in the latter part of 1912, was one by E. C. Harder[1] on the iron-ore deposits of the Eagle Mountains, Cal. It is an economic paper dealing with the structure, character, and quantity of the ores and their relations to the associated rocks. These iron-ore deposits are in the northern part of the Eagle Mountains in the desert country in northern Riverside County, Cal. The nearest railroad is the Arizona & California Railroad, which passes about 35 miles northeast of the Eagle Mountains.

[1] Harder, E. C., Iron-ore deposits of the Eagle Mountains, Cal.; Bull. U. S. Geol. Survey No. 503, 1912, 81 pp.

According to Harder the portion of the Eagle Mountains containing the iron-ore deposits is structurally an oval dome extending in a general east-west direction across the range. The dome is composed of sedimentary rocks and intrusive granitic rocks. The following section is given by Harder[1] of the formations composing the dome:

General section of rocks in the northern part of the Eagle Mountains.

5. Scoriaceous and massive basalt and other flows.
4. Quartz monzonite containing lenses of quartzite and conglomerate.
3. Quartzite, conglomerate, crystalline dolomite, ophicalcite, iron ore, and metamorphic minerals (mineralized rock). (Dolomite-quartzite series.)
2. Vitreous quartzite intruded by quartz monzonite and consisting of schistose-arkose in the upper part. (Vitreous quartzite series.)
1. Gneiss, schist, and quartzite, with locally thin layers of crystalline limestone.

As to the occurrence and general character of the iron-ore deposits, Harder gives the following descriptions:[2]

IRON-ORE DEPOSITS.

The iron ores with associated metamorphic minerals occur as replacements in the dolomite. Locally, as at the east end of the area, they have replaced the entire series of dolomite lenses, leaving the associated quartzite but little altered. Elsewhere they occur within the dolomite lenses or beds in bands or as irregular masses roughly parallel to the bedding. All the deposits occur along the horizon of dolomite lenses, the principal ones being on the north limb of the dome. The trend of the iron-bearing belt along the north limit is approximately N. 70° W., its extent in this direction being about 6½ miles. Its width of outcrop varies from 500 to 2,500 feet. At the west end the horizon of dolomite lenses curves southward around the end of the dome in an irregular semicircle about 2 miles in diameter and then runs back eastward along the south limb of the dome, gradually getting nearer the north limb, so that at the east end they are scarcely half a mile apart. It has a maximum width of about 4,000 feet at the west end but becomes thinner along the south limb. A westward extension of it, nearly a mile long, occurs at the southwest end of the dome, and on this is located the Iron Chief mine.

Small scattered iron-ore deposits occur in the dolomite belt at the west end of the dome and continue for half a mile eastward along the south limb. The rest of the south limb is almost barren of iron ore. Other deposits occur in the vicinity of the Iron Chief mine, in the westward extension, and in the outlying dolomite areas west of the dome. All of these deposits, however, are of little or no importance when compared with the extensive masses along the north limb, where there is an almost continuous series of deposits, occurring in some places in a single band and in others in two bands from several hundred to a thousand feet or more apart. The largest ore bodies are at the east end and the west end of this belt. Smaller ones occur at intervals between them. The largest body of mixed ore and gangue material is discontinuously exposed for a distance of about 6,000 feet and has a maximum width of outcrop of 500 feet. From this the deposits range down to a few feet in extent.

The ore is predominantly hematite, but here and there consists of masses of magnetite. Much of the hematite contains disseminated magnetite, making it slightly magnetic, but probably less than 10 per cent of the entire quantity of ore is magnetite. A considerable percentage is very pure and of high grade, containing between 62 and 67 per cent metallic iron and less than 0.06 per cent phosphorus. Much of the ore, however, is mixed with gangue material, such as metamorphic minerals and unreplaced rock. The principal minerals occurring with the ores and metamorphosed dolomite are serpentine, mica, amphibole, garnet, epidote, pyroxene, and titanite. * * *

CHARACTER AND GRADE OF THE ORE.

The ore is largely hematite; subordinately magnetite. Limonite or goethite occurs in a few places. There is apparently no definite relation between the hematite and the magnetite as regards distribution, the magnetite occurring abundantly in some places while elsewhere it is almost absent. It may occur in large bodies with little

[1] Op. cit., p. 24.

[2] Op. cit., pp. 25–26, 63–66.

or no hematite, or it may be disseminated through hematite masses in small specks and grains.

The hematite is dark red and ranges in texture from coarsely crystalline to finely granular. All the crystalline ore and most of the granular ore is very hard, but local pockets of soft granular ore have been encountered underground, as in the tunnel on the Wizard, suggesting that with depth a greater proportion of the ore may be soft. In other places, however, pits have been sunk into hard ore to a depth of 15 or 20 feet without encountering soft ore. With the small amount of exploratory work done up to the present it is impossible to make conjectures as to whether a general change in the character of the ore may be expected with depth. Indications are that the distribution of soft ore is local. The magnetite is usually hard and granular, but in places where large masses of it are found some of it is coarsely crystalline and when broken presents shiny black surfaces.

The purest masses of iron ore consist in most places of hematite; the impure ore masses in which there is much serpentine and a gangue of metamorphic minerals contain a large percentage of magnetite. The ore occurring along the white carbonate veins consists largely of magnetite. Local masses of pure, high-grade magnetite are found, however, with little or no gangue material, but such occurrences are not abundant.

The hydrated oxides of iron are rare. Thin films occur in places as a coating on the other ores, being formed from these by hydration. On [claim] Iron No. 30 hydrated oxides are formed in rounded masses with dense texture and conchoidal fracture embedded in ore masses consisting largely of hematite and magnetite.

Although crystalline structure is characteristic of most of the ores, well-developed crystal forms are not abundant. Locally, however, they line cavities in ore masses or associated rocks or are disseminated through metamorphic mineral masses or unreplaced rock. The crystal forms found suggest that pyrite and magnetite were the original minerals. Both, however, are usually altered to hematite, though the pyrite is sometimes altered to limonite. Of the pyrite forms striated cubes are most abundant, many of these being modified by the octahedrons. Rarely perfect octahedrons occur modified by the pyritohedron. The characteristic magnetite form is the dodecahedron without modification. The magnetite and pyrite crystal forms are intimately intermixed and were evidently deposited simultaneously. The pyrite forms are somewhat more abundant than the magnetite forms.

The hematite is apparently for the most part secondary after pyrite and magnetite. One small body of coarsely crystalline specular hematite, originally deposited as such, occurs on the Superior group of claims, in the outlying limestone areas, several miles west of the domical area. With the exception of this mass, however, none of the hematite can be said to be undoubtedly original.

A large proportion of the ore is intermixed with metamorphosed rock and must be concentrated before it can be used in the blast furnace. This is true of probably more than half of the bulk of the ore-bearing beds. A large amount of pure ore, however, which can be shipped directly to the furnaces, occurs in parts of the district. The distribution of the pure ore in the ore-bearing rock is irregular. In some places large bodies of it contain small masses of gangue material; in other places small bodies of pure ore are distributed through ore-bearing rock. The ore-bearing gangue material consists of the various phases of altered dolomite and quartzite, changed by metamorphism to mica, amphibole, pyroxene, serpentine, and other minerals.

The ore itself is of high grade, containing a large percentage of metallic iron and a small percentage of phosphorus. None of the impurities are present in sufficient amount to be injurious.

* * * Average analyses show that the percentage of iron oxide in the ores ranges from 89.3 to 95.71, giving a corresponding metallic iron content of 62.5 to 67 per cent. Rarely samples may run as low as 54 per cent or as high as 68.6, but the average run of analyses is between 64 and 67 per cent. For comparison it may be noted that the ore mined in the Lake Superior district at present averages about 58 per cent metallic iron.

The average range of phosphorus is between 0.028 and 0.058 per cent, thus making practically all the ore of Bessemer grade. Rarely, however, samples are obtained in which the phosphorus runs as high as 0.21 per cent or as low as 0.01 per cent. * * *

The content of silica ranges between 2 and 6.7 per cent, which appears to be very low when it is remembered that even the calcareous Clinton ores of the Birmingham district generally contain more than 7 per cent silica. Lime ranges from 0.25 to 1.04 per cent and magnesia from 0.2 to 2.16 per cent. Silica, magnesia, and lime will increase with the increase of gangue minerals, which are mostly silicates. Increase of these constituents will mean a proportional decrease in the metallic iron content.

Sulphur ranges from 0.038 to 0.214 per cent.

The manganese content is negligible, and copper and titanic oxide were absent altogether in the one sample which was examined for them. * * *

Estimates of the quantity of available ore and notes on the development and commercial importance of the district, as given by Harder, are as follows: [1]

ESTIMATES OF QUANTITY OF ORE.

The largest single deposit of ore and associated gangue minerals in the district occurs along the upper ore horizon in the east end group of deposits. This ore body is exposed discontinuously for a distance of nearly 6,000 feet. It has a maximum width of outcrop of about 500 feet and a maximum thickness of about 325 feet. It dips to the north at angles ranging from 30° to 55°. On the supposition that the body extends down the dip 300 feet from the center of the outcrop it would contain nearly 40,000,000 tons of mixed ore and gangue material. A rough estimate would make less than one-third of this gangue material.

Similar calculations, based on the best available information concerning the structure, have been made with regard to all the other large deposits in the district. The extent of the ore bodies beneath the surface can, of course, be judged only from structure and from the surface outcrops. The greatest vertical distance through which any of the ore bodies are exposed is 350 feet, and from this it may be judged that most of the large ore bodies extend at least 300 or 400 feet down the dip. It is likely, however, that the deposits may extend many times as far; indeed, judging from the longitudinal extent of the ore-bearing beds, it is more than likely.

A moderate estimate of the total quantity of mixed ore and gangue material available in the deposits now exposed, assuming that they extend several hundred feet down the dip (the exact depth taken varying with the size of the deposits), is about 75,000,000 tons. Of this quantity probably less than one-fifth may be assumed to be gangue material and the rest ore, most of it of very high grade. This estimate does not include large quantities of contact rock that contain a variable percentage of magnetite and hematite. It should also be remembered that the estimate may be greatly increased if it is assumed that the ore-bearing beds continue farther down the dip.

DEVELOPMENT AND COMMERCIAL IMPORTANCE.

No iron ore has been mined in the district, and except at the Iron Chief mine only enough work has been done to meet the requirements for patent. All the principal deposits of the district belong to the Iron Chief Mining Co.

About 100 pits, shafts, and tunnels have been sunk in development and assessment work on the iron ores. This number does not include the workings of the Iron Chief gold mine, in which considerable quantities of magnetite were encountered. The longest tunnel is 124 feet long; the deepest shaft is 18 feet deep. The greatest depth reached beneath the surface is at the end of the longest tunnel (on Rodger No. 2), a distance of about 42 feet below the surface. No diamond drills have been used in the district. A great many of the workings are along contacts of ore and dolomite or mineralized rock and are an aid in defining the ore bodies, as well as in showing the effects of metamorphism and the geologic relations in general. The most important workings are in the Wizard, Rodger No. 8, Katie Gray, Rodger No. 5, Rodger No. 2, Iron No. 2, Iron No. 26, Iron No. 27, and Iron No. 30.

The Iron Chief mine is on the Gray Eagle claim, one of the Gray Eagle group. It consists of one main shaft with drifts at two levels, both of which communicate with the surface by tunnels. Several stopes and chambers have been excavated at points where shoots of gold ore were found. A stamp mill, with settling vats, was built on the slope just north of the main shaft. Considerable gold was taken from the mine, but the ore eventually became too scattered and lean to pay for operations. Water was obtained from Cottonwood Springs through a pipe line.

At present there is no way of utilizing the iron ore of the district. It is far from transportation lines, and even if a railroad were built to the deposits the cost of transportation to the nearest furnaces would eat up the profit. It is beyond doubt, however, that before long blast furnaces and steel plants will be established at points in southern California, as they are now being established on Puget Sound, and in this event the Eagle Mountain ores will probably be among the first to be utilized.

[1] Op. cit., pp. 66–69.

A large quantity of high-grade Bessemer ore is in sight, besides a large quantity of impure ore that must be concentrated mechanically before it can be used in the blast furnace. Judging from the preceding estimates, enough high-grade ore is in sight to supply a modern blast furnace of a daily capacity of 500 tons of pig iron for more than 200 years.

Limestone and dolomite available for flux, though not especially abundant in the southern part of California, occur at numerous scattered localities in Mohave and Colorado deserts and in the San Bernardino Mountains. The dolomite of the Eagle Mountains associated with the iron ores might be utilized for flux to some extent, but the abundant association with them of ophicalcite and silicate rock makes a large percentage of it unsuitable for smelting operations.

Harder regarded the absence of fuel as one of the principal obstacles to the establishment of an iron industry in southern California, believing that the bituminous coals of Washington were unsuitable for coking. It has been shown, however, that fairly good coking coals are mined in several places in Washington,[1] and that good furnace coke can also be obtained from the Raton-Trinidad coal field of Colorado and New Mexico and the Castle Gate district of Utah. These facts, together with the possibility that coking coal may be mined in Alaska within a few years, give rise to the hope that the lack of a local fuel supply will prove only a temporary obstacle, and that eventually blast furnaces may be put in operation in southern California.

TITANIFEROUS MAGNETITE IN NORTHWEST MONTANA.[2]

While making a geologic examination of the Blackfeet Indian Reservation in northwest Montana in 1911 and 1912, Eugene Stebinger, of the United States Geological Survey, noted a number of lenticular magnetite-bearing sandstone beds in the west half of the reservation. The principal beds are on South Fork of Milk River, in T. 37 N., R. 9 W.

These magnetite-bearing sandstone beds are in rocks of Upper Cretaceous age, are underlain by the Bearpaw shale, and overlain by the St. Mary River formation. The beds are composed mainly of coarse-grained gray sandstone containing chiefly quartz and altered feldspar. The upper one-third of the sandstone is massive, and in most places where the formation is nearly horizontal it forms an escarpment along the outcrop. This renders the sandstone conspicuous, and it can be traced for nearly 60 miles, from south to north, entirely across the reservation. The zone containing the magnetite beds lies at the top of this massive sandstone, but there are places which do not contain any beds of magnetite, their horizon being occupied rather by beds of greenish-gray ferruginous sandstone, which weathers to a dark reddish brown. The ferruginous band is typically developed on Horsethief Ridge in T. 35 N., R. 9 W., and on the escarpment in the township adjoining on the north. The thickness of the magnetite-bearing sandstone varies considerably, measurements of 235 feet and 360 feet having been made at points 30 miles apart.

The structure of the rocks underlying the Blackfeet Indian Reservation offers strong contrasts. In the western part the rocks have

[1] Smith, E. E., Coals of the State of Washington: Bull. U. S. Geol. Survey No. 474, 1911, pp. 31-33.

[2] Stebinger, Eugene, Titaniferous magnetite beds on the Blackfeet Indian Reservation, Montana: Bull. U. S. Geol. Survey No. 540-H, 1913.

been much folded and faulted, while in the eastern part the structure is very simple, the rocks having been only slightly disturbed and either lying horizontal or showing dips ranging from a very small angle to 5° to the west. In the area of highly tilted rocks the strike is northwest-southeast, and the outcrops of the magnetite-bearing lenses appear on a map as small flaxseed-shaped areas, all oriented in the same general direction.

The following quotations from Stebinger's paper will serve best to describe the occurrence and character of the magnetite beds:

OCCURRENCE AND CHARACTER OF THE MAGNETITE BEDS.

The magnetite beds on the Blackfeet Indian Reservation are confined very persistently to a zone occupying the upper 25 feet of the sandstone formation in which they are found. Although this zone does not always contain beds that are rich in magnetite, it is nearly everywhere distinguished by sandstones that are much more ferruginous than the underlying rocks and therefore weather with a dark iron stain, making them very conspicuous. Where the deposits rich in magnetite occur, the zone usually consists of two to four beds of high-grade rock intercalated with leaner sandstones. * * * In some places, however, only one bed occurs, varying from only a few inches to as much as 6 feet in thickness and associated with more or less lean sandstone having a very low iron content. The beds rich in magnetite are more indurated and therefore resist weatherng better than the lean sandstones, standing out in small steplike ledges. The entire deposit acquires on weathering a deep reddish brown or rusty color which presents a marked contrast to the light buff to gray of the underlying sandstone.

The rock in the iron deposits here described, when examined with the naked eye on a fresh face, is seen to be a dense fine-grained aggregate composed mainly of magnetite. By turning the hand specimen in the light, the minute metallic faces of the individual magnetite grains can be plainly seen, but other minerals can not be distinguished except in rock of very low grade, in which minute specks of feldspar and quartz are visible. In places the ore presents a finely banded appearance due to the alternation of small blackish layers of almost pure magnetite with light-gray layers composed chiefly of quartz and feldspar. The banding is in many places perfectly developed, individual layers being rarely over one-fourth of an inch thick and ranging from that thickness down to a knife-edge. The color of the iron rock varies from a dull black in material carrying from 40 to 50 per cent of iron to a deep greenish black in material carrying from 25 to 30 per cent. The specific gravity also varies with the iron content, averaging about 4.5 in the higher-grade rock and much less in the leaner material. The low-grade parts of the deposits could be readily separated from the richer material by hand sorting, because of the lower specific gravity and lighter color.

As seen under the microscope, the magnetite-bearing sandstone is a typical clastic aggregate with magnetite, quartz, and altered feldspars as the dominant minerals and zircon, garnet, titanite, and ilmenite as accessory minerals. Silica and an unidentified chloritic mineral are the principal cementing substances. The rock is undoubtedly of sedimentary origin and is very probably an indurated "black sand" such as occurs in many places along present sea beaches, especially along the Pacific coast. Day and Richards,[1] in a study of black-sand deposits which included most of the well-known beach sands of the Oregon and California coasts, found that ilmenite, garnet, and zircon, in the order named, were the most abundant accessory minerals commonly found in black sands.

Analyses of four samples of magnetite-bearing sandstone from widely scattered localities on the Blackfeet Indian Reservation show an iron content ranging from 27.3 to 49.3 per cent. The samples for analyses 2721 a, b, and c, given below, were all obtained by cutting a channel across the face of the outcrop of the deposits and then mixing and quartering the material thus obtained so as to give as true an average as possible. Sample 2658 was a hand specimen of average material. The amount of titanium oxide present in the samples varies from 8.3 to 12.8 per cent and is probably contained not only in the titanium-bearing minerals, ilmenite and titanite, but also in the magnetite.

[1] Day, D. T., and Richards, R. H., Useful mineral in black sands of the Pacific slope: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 1228.

At present iron ores containing more than 1 per cent of titanium oxide are considered to be of no commercial value, regardless of the amount of iron present, because the material can not be smelted successfully. The iron that can be smelted from such ores is of good quality, the only difficulty being that the titanium-bearing slags are too viscous and sticky to allow successful furnace operations. However, metallurgists [1] are not hopeless as to the possibilities of eventually being able to smelt, titaniferous iron ores, and it is not improbable that they will finally be used in making titanium tool steel.

Partial analyses of samples from the magnetite deposits of Blackfeet Indian Reservation Mont.

[F. W. Clarke, chemist in charge.]

	2721a	2721b	2721c	2658
Location	NE. ¼ sec. 30, T. 37 N., R. 9 W.	SW. ¼ sec. 29, T. 37 N., R. 9 W.	SE. ¼ sec. 13, T. 33 N., R. 12 W.	NE. ¼ sec. 9, T. 3 N., R. 9 W.
Total thickness of beds included in sample.	9 feet 4 inches	2 feet 4 inches	7 feet	Grab sample.
Fe	27.3	33.2	49.3	35.73
TiO_2	8.3	10.6	6.8	12.81
S	.034	.018	.080	Not det.
P_2O_5	None.	.16	.073	Not det.
SiO_2	Not det.	Not det.	Not det.	29.62

As a result of his studies of the subject, Stebinger reaches the following conclusions concerning the origin, quantity, and commercial importance of these deposits:

CONCLUSIONS.

1. The magnetite beds of the Blackfeet Indian Reservation are of sedimentary origin and are restricted to a zone at the top of a sandstone formation of Upper Cretaceous age.

2. The beds show a close mineralogic resemblance to the accumulations of "black sands" which are found in many places along present-day beaches of the Oregon and California coasts.

3. The beds were not laid down over the entire area of the formation in which they occur, but seem to have accumulated only in a number of small, widely scattered areas which contain rich magnetite sandstones reaching a thickness of 9 feet, although the average thickness is not over 4 to 5 feet.

4. A considerable tonnage of ore which would average about 50 per cent of iron could be hand sorted from these deposits, although the average of the material available would probably not run more than 30 to 40 per cent.

5. The proportion of titanium oxide in the ores is considerable, averaging over 12 per cent in one sample. This high titanium content renders these ores unfit for use, according to present metallurgical practice, although it must be recognized that ores of this type may eventually be successfully smelted.

"CLINTON" HEMATITE IN EASTERN WISCONSIN.[2]

In this paper Thwaites presents notes on certain well records which show the presence of the "Clinton" iron ore at several heretofore unsuspected localities, and suggests the advisability of exploration for this important iron ore.

The "Clinton" iron ore in eastern Wisconsin resembles in certain important respects the Tennessee-Alabama-Georgia "Rockwood" ore described elsewhere in this paper. It is hematite, is of Silurian age,

[1] See Rossi, A. J., Report on titanium ores in blast furnaces: Trans. Am. Inst. Min. Eng., vol. 21, 1893, p. 283.

[2] Thwaites, F. T., Recent discoveries of "Clinton" iron ore in eastern Wisconsin: Bull. U. S. Geol. Survey No. 540-H, 1913.

is of sedimentary origin, and occurs in broad, lenticular beds. In texture the Wisconsin ore is more largely oolitic or granular than is the ore found in the southern Appalachians, and in this respect resembles the oolitic phase of the Clinton ore of New York. The content of metallic iron in the Wisconsin ore ranges between 30 and 50 per cent, the phosphorus runs over 1 per cent, and there are varying percentages of calcium carbonate and silica.

"Clinton" iron ore is mined at only one place in eastern Wisconsin—at Iron Ridge, near Mayville, Dodge County. At this place the ore underlies a bold west-facing bluff of Niagara dolomite and has been mined from the outcrop and underground. The thickness of the ore worked here ranges from 6 to 30 feet. The ore as shipped from this mine contains from 40 to 47 per cent of metallic iron. It is reduced in blast furnaces at Mayville and Milwaukee, Wis., and it is mixed with richer ore from the Lake Superior district.

In eastern Wisconsin the strata dip at a low angle eastward below Lake Michigan. Two apparently separate lenses are mined at Iron Ridge, the longer axes of which, so far as is known, extend in an east-northeast and west-southwest direction, and it is reported that several million tons of ore have been indicated by drilling to the east and northeast of the outcrop and that the ore body is being developed by a shaft 2 miles from the outcrop. One other outcrop of "Clinton" ore has been noted—near Green Bay, Wis., where the maximum thickness is less than 5 feet. Much of the outcrop of the base of the Niagara dolomite, at which horizon the iron ore may be expected, is deeply covered by glacial drift, and consequently there has been little search for the ore along this line.

East of the outcrop comparatively few wells are deep enough to penetrate the ore horizon, and of the deep wells, only a few records show indications of the presence of "Clinton" ore. In certain of these, however, ore has been shown, and in others the record "red rock" is now suspected to mean "Clinton" ore, although little is known of its character. The localities where the presence of ore has probably been indicated by well drillings, according to Thwaites, together with other related information, are shown in the following table:

Localities indicating presence of "Clinton" ore in eastern Wisconsin.

Town.	County.	Number of wells.	Depth to ore horizon.	Probable thickness of ore.	Remarks.
			Feet.	*Feet.*	
Hartford	Washington	Several.	20 to 100	A few to 20	Possibly interstratified with limestone.
Germantown	do	2			"Red rock."
Ashippun	Dodge	Several.	10 to 135	8 to 20	Float ore also found.
Delafield (near)	Waukesha	2			"Red rock."
Sommers	Kenosha	1	333	18	Iron ore reported.
Manitowoc	Manitowoc	1	825	55	Upper 30 feet of promising quality.
	Door	Several.			"Red rock."

In view of these significant records, none of which have been verified by further exploratory work, Mr. Thwaites, who is curator of the geological museum of the University of Wisconsin, emphasizes the great practical value of preserving samples during the drilling of deep wells and of submitting them to expert examination. Since the depths at which this ore may occur are not prohibitive to mining and since encouraging thicknesses of ore have been indicated at several localities, it appears that some of the localities, at least, may be worthy of consideration for exploration.

RED IRON ORE IN TENNESSEE, ALABAMA, AND GEORGIA.

GENERAL STATEMENT.

The paper dealing with the red iron ores of east Tennessee, northeast Alabama, and northwest Georgia[1] was prepared by the writer.

The red iron ores of these three States occur in seams or beds analogous to beds of coal, and they outcrop more or less continuously on the borders of long narrow anticlines and broader synclines of the southern Appalachians. The red iron ores of this region consist of hematite mixed with varying quantities of calcium carbonate, silica, and alumina, and contain minor percentages of sulphur, phosphorus, and manganese. They contain very little combined water and are thus distinguished from brown iron ore, or limonite. The most important beds of red ore are of Silurian age, and are found in the "Rockwood" formation as described in the United States Geological Survey folios of the southern Appalachian region. Other red ores described in this paper are of Ordovician age, occurring either in the Tellico sandstone or as residual deposits upon this formation, and of Mississippian age, as beds in the upper part of the Grainger shale.

The ore is termed "hard" or "soft" according to whether it is in an unaltered or unweathered state or whether it has been so acted upon by surface water and other agents of weathering that its soluble constituents, such as calcium carbonate, have been dissolved out, leaving the ore porous and in general in a softer state physically than the unaltered or "hard" ore. With the removal of calcium (lime) carbonate by solution the percentage of iron and other constituents is increased proportionately, so that the soft ore is generally considered the richer of the two varieties. The presence of lime carbonate in the hard ore, if not in excess of the proportion needed to flux the silica and alumina in the ore, coke, and limestone, is of course an advantage that partly offsets the deficiency of iron in an ore.

The writer's work on the iron ores of this region was begun in 1906 and has been carried forward at intervals up to the present time (spring of 1913). The present report is preliminary to one which shall cover in detail the area extending from the Birmingham district (described in Bulletin 400) to the Tennessee-Virginia line.

Prospecting the ore beds.—Until recently in examining the bedded iron ores of these areas the author has been obliged to depend entirely upon natural exposures of the ore beds or upon exposures made by mining operations, roads, tunnels, etc. The soft, shaly nature of

[1] Burchard, E. F., Preliminary report on the red iron ores of east Tennessee, northeast Alabama, and northwest Georgia: Bull. U. S. Geol. Survey No. 540-G, 1913.

much of the rock overlying the red ore causes the shale above a fresh ore prospect to "slump" down within a few months and practically to cover up a showing of ore. The result is, therefore, that except where mining is actually in progress there are very few exposures of ore beds, even though many fresh prospects may have been made within a year. The geologist who attempts to prepare a report on such an ore field must either accept much hearsay evidence concerning the thickness and character of the ore beds, or else he or a member of his party must see and measure every section on which the report is based. This latter plan was consistently carried out in the recent field work in the southern Appalachians. In order that no very long gaps should occur between measured sections, the ore beds were prospected on the outcrop at points where actual measurements were of importance. In many places it was necessary only to clean out old prospects, but in others fresh prospects were dug. Wherever practicable the bed was cut back to firm ore, in order to ascertain its true thickness. At many of these prospects samples of ore were taken for analysis by the Survey.

IRON ORE IN TELLICO SANDSTONE.

DISTRIBUTION.

Interbedded with the shale in the Tellico sandstone, there are in a few localities in east Tennessee thin seams or lenses of ferruginous material of limited extent, which vary from a ferruginous, calcareous sandstone to a rich, compact material composed mainly of iron oxide. The richest beds range in thickness from a few inches to 18 inches, and much greater thicknesses of lean material have been measured. Where the Tellico sandstone has been disintegrated by weathering and fragments of residual ore have been concentrated in basins on the surface of harder rocks, deposits of economic importance may be formed.

Iron ore has been found in the Tellico sandstone in Tennessee near Tuckahoe Creek, east of Knoxville; near Sweetwater, Monroe County; and near Riceville, McMinn County; and in rocks of nearly equivalent age near Rock Mart, in Georgia. Careful field examination has shown that under present conditions only the deposits near Sweetwater and near Knoxville, Tenn., the richest parts of both of which are residual in character, can be considered of economic importance. Of these two deposits, that near Sweetwater is being worked at present, as it is near a railway. The ore near Sweetwater requires sintering. Although the quantity available here is limited, it is probably sufficient to prove a valuable addition to the reserves of much needed siliceous ore tributary to Chattanooga. Commercial grades of Sweetwater ore in the raw state carry 35 to 50 per cent metallic iron, 15 to 20 per cent silica, 10 to 12 per cent alumina, 1.75 to 2.75 per cent manganese, 0.10 to 0.50 per cent phosphorus, 0.05 per cent sulphur, and 2 to 4 per cent water. The ore that occurs near Tuckahoe Creek, east of Knoxville, carries about the same percentage of metallic iron, but its insoluble material, its phosphorus, and its sulphur are all probably greater than those of the Sweetwater ore.

IRON ORE IN THE "ROCKWOOD" FORMATION.

DISTRIBUTION.

The "Rockwood" iron ore in Tennessee, Alabama, and Georgia is nearly, but not quite, coextensive with the "Rockwood" formation in these States. The exceptions are a few areas where the formation carries little more than a few streaks of ferruginous sandstone or ferruginous limestone. The ore-bearing formation underlies the great plateau areas, such as Cumberland Plateau, Walden Ridge, Sand Mountain, Lookout Mountain, Pigeon Mountain, etc., which are all broad synclinal areas, and it outcrops in the valleys bordering these plateau areas. There are also certain areas of less extent within the valley of east Tennessee and in northwest Georgia, where the iron ore underlies narrow synclinal basins, whose continuity has been broken by erosion and faults.

EAST TENNESSEE.

The "Rockwood" ore in east Tennessee outcrops along the foot of the Cumberland escarpment from the southern border of the State below Chattanooga to the northern border of the State at Cumberland Gap and in several separate areas in the Tennessee Valley. The Cumberland outcrop is not continuous, because in a number of thrust faults the formation has been buried below older rocks. There are, however, strips of outcrop that extend distances of 15 to 20 miles continuously. The normal dip of the rocks along the escarpment is toward the northwest, but in many places the ore beds outcrop to the southeast or away from the mountain. This reversed dip is due to the strata having been overturned during the folding of the earth's crust, and it extends from a few feet to hundreds of feet below the surface. The iron ore beds extend under the Cumberland Plateau for unknown distances. In the northeast part of the State it is very probable that the bed is continuous between Powell Valley and Elk Valley, the outcrop in Elk Valley being due to faulting and erosion. Near Caryville the southwestward extension of the ore is cut off by a cross-fault, which extends northwest as far as Elk Valley and here also cuts off the ore that is exposed in that valley, thus forming a block of strata bounded on the southeast by Powell Valley, on the southwest by Coal Creek, on the northwest by Elk Creek, and on the northeast by a fault which passes through Cumberland Gap. Along the escarpment between Coal Creek and Harriman, the ore is cut out locally by several thrust faults, so that only three limited areas of outcrop are found. From Emory Gap southwest to near Glen Alice the ore outcrop is more or less continuous, and in this area from Cardiff to Rockwood occurs one of the thickest and most valuable lenses of ore that has been opened anywhere in the State. Between Glen Alice and Spring City there is one important break due to faulting, but southwest from Spring City to Retro the ore outcrop is practically continuous. Between Retro and Rathburn there is a break followed by a strip of ore outcrop measuring about 2½ miles in length, beyond which no ore is found until the valley of Falling Waters Creek is reached. From Falling Waters Creek southwestward to the State line the ore outcrop is practically continuous, and it is duplicated on both sides of a narrow anticlinal arch. This arched structure also occurs from

Hill City southward to the State line in a second outcrop which lies 1 to 2 miles east of the main outcrop at the foot of the Cumberland escarpment and passes through the city of Chattanooga.

In the Tennessee Valley the several areas of "Rockwood" ore are formed by beds that have been folded in among strata of earlier age. The most important of these are situated near Chamberlain, a few miles south of Tennessee River in Roane County, and along Tennessee River near Euchee, Meigs County. These outcrops are mostly in the form of synclinal basins of "Rockwood" formation modified by more or less folding and faulting. Just northeast of Decatur a small area occurs which is bounded on the east by a fault, and farther south, Whiteoak Mountain forms the west limb of a syncline in which ore occurs extending from the State line northward several miles from Ooltewah. Soft ore has been stripped from the outcrop along nearly the whole extent of outcrop in the State, the only exceptions being in localities too remote from railroads or navigable streams. The ore has been mined underground at Lafollette, to a very small extent near Elk Valley, extensively between Emory Gap and Rockwood; and a few small drifts or tunnels have been driven near Glen Alice. Considerable underground work has been done in the vicinity of Chamberlain and Euchee, and a little near Ooltewah. The possibility of underground mining has, of course, depended on the thickness of the ore bed and upon the quality of the hard ore below the limit of weathering, as well as on transportation lines.

If placed end to end the outcrops of "Rockwood" ore along the base of Cumberland escarpment, considered as but one ore seam, would aggregate 160 linear miles. If the valley outcrops be similarly considered it brings the total linear outcrop of "Rockwood" ore beds in Tennessee up to 245 miles. Out of this total probably 60 miles of outcrop may be considered as workable for hard ore, so far as quality and thickness are concerned, to whatever distances below the outcrop may be permitted by mining conditions. The ore beds range in thickness from an inch to 7 or 8 feet, but are not generally more than 3½ feet thick. Two feet is considered to be about the minimum workable thickness underground, unless the ore is of extraordinary quality. On the outcrop, where the bed may be stripped and mined from an open cut a much smaller thickness of ore may be profitably mined.

NORTHEAST ALABAMA.

The area here considered extends from Attalla and Gadsden, Ala., northeastward to the Alabama-Georgia line.

The "Rockwood" ore bed which probably underlies the greater part of the Lookout Mountain syncline outcrops, except where cut out by faults, along the northwest and southeast borders of the mountain.

Northeast from Attalla the ore bed outcrops in a low ridge called Red Mountain that extends parallel to and at a distance of 1 to 1½ miles from the northwest base of Lookout Mountain. The dips are here toward the southeast. On the opposite or northwest side of Wills Valley the ore bed also outcrops with steep northwest dips except where it has been overturned or else interrupted by faults. This latter outcrop approximately parallels the Red Mountain outcrop at a distance of about 3½ miles from the latter. Wills Valley extends along the axis of an anticline with the ore beds and

associated rocks dipping away on either side toward the synclinal basins of Lookout Mountain and Sand or Raccoon Mountain. The Alabama Great Southern Railroad passes along a narrow valley between the west border of Lookout Mountain and Red Mountain and is nearly everywhere within about 1 mile of the outcrop of the ore bed in Red Mountain.

Along the southwest end of Lookout Mountain, between Attalla and Gadsden, the outcrop of the "Rockwood" ore is cut off by a fault. From Gadsden northeastward the ore outcrops for a distance of about 20 miles in Shinbone Ridge nearly to Yellow Creek, where it is cut off by a fault. The fault interrupts the ore outcrop for a distance of about 2½ miles. Near Sterling Gap the ore is found in the section and may be traced practically continuously northeastward in Shinbone Ridge to the Alabama-Georgia line, a distance of 19 miles. The Shinbone Ridge outcrop represents the southeast limb of the Lookout Mountain syncline. The dips here are generally steep toward the northwest, or they may be overturned toward the southeast. The Tennessee, Alabama & Georgia Railroad traverses the narrow valley between Lookout Mountain and Shinbone Ridge, and is nearly everywhere between one-fourth and one-half of a mile from the ore outcrop.

The only other "Rockwood" ore locality in this portion of northeast Alabama remaining to be mentioned comprises a ridge lying north of Coosa River, the southwest end of which is known as Tucker Ridge, and the northeast end, which extends into Georgia, is known as Dirtseller Mountain. A small outlier of Tucker Ridge, known as Round Mountain also carries "Rockwood" ore. The ore bed in Tucker Ridge dips moderately to the southeast and for several miles forms a narrow synclinal basin the axis of which rises to the northeast. The Tucker Ridge outcrop extends northeast-southwest for about 12 miles, and for about half that distance it is closely paralleled by a lower ridge carrying ore dipping northwest, and representing the southeast edge of the syncline. The Rome and Attalla branch of the Southern Railway passes to the south of this area, the village of Cedar Bluff being about 3 miles from the nearest ore outcrop on Tucker Ridge. This ore-bearing area has been known also by the terms "Gaylesville" area and "Mill Creek" area, on account of the proximity of the town and creek so named.

The "Rockwood" iron ore areas in northeast Alabama outlined above, lie principally in the Fort Payne quadrangle, although the southwest extremity extends a few miles into the Gadsden quadrangle and the northeast portion extends a few miles into the Stevenson and the Rome quadrangles. Placed end to end this outcrop aggregates about 160 miles, of which possibly 75 miles are of workable ore. The total of 160 miles does not include the outcrops in Browns Valley and in Murphrees Valley, neither of which had been studied by the Survey at the time this report was prepared.

NORTHWEST GEORGIA.

Most of the "Rockwood" iron ore outcrops in northwest Georgia are direct continuations of the outcrops in Alabama just outlined. On both sides of Lookout Valley the ore outcrops are continuous from Pudding Ridge to the Tennessee line, the eastern outcrop dipping under Lookout Mountain, the western outcrop dipping below

Sand Mountain. The Wills Valley outcrops end in Johnson Crook, where the "Rockwood" strata are exposed around the "nose" of the anticline. On the east side of Lookout Mountain the Shinbone Ridge outcrop extends northeast to the extremity of Pigeon Mountain, around the end of that mountain into McLamore Cove, thence northeastward on the east flank of Lookout Mountain, and terminates in a fault near Flintstone, 2¾ miles south of the Tennessee line. The Tuckers Ridge and Dirtseller outcrop continues northeast into the Dirtseller synclinal area, which terminates about 2 miles west of Lyerly, Ga., and shows two outcrops of ore, which converge and unite at the end of the syncline. In addition to these outcrop areas, the "Rockwood" formation in Taylor Ridge carries iron-ore beds. The ore in Taylor Ridge is thickest in the locality east and southeast of Summerville, but a very thin bed may be traced northeastward to beyond the Tennessee line into the Whiteoak Mountain area. The entire length of outcrop of the "Rockwood" iron ore in Georgia aggregates about 175 miles, but for a considerable part of the distance the ore is too thin to be of commercial value.

The thickness of the "Rockwood" iron-ore beds in northeast Alabama and northwest Georgia ranges from an inch up to about 5 feet, but it is generally not more than 3 feet. In some places there may be two fairly good seams within 20 to 30 feet of the formation, and in other places no workable seam can be found, the deposition of iron being represented by six or eight seams, ranging between 1 inch and 12 inches thick, distributed through perhaps 40 feet of shale of the "Rockwood" formation.

IRON ORE IN GRAINGER SHALE.

The area of Grainger shale reported to contain iron ore lies 6 to 7 miles in an air line southeast of Maryville, Blount County, Tenn., along "Little Mountain" or the foothills of Chilhowee Mountain, and 2 to 3 miles southwest of Little River.

The Grainger shale, a formation of Devonian and Carboniferous age, here consists mainly of shale and sandstone, dipping southeast at low angles into the hills. Several small creeks flowing northwestward down the slope have cut narrow gulches through the formation at right angles to the strike of the beds, and thus afforded sections across some rather ferruginous rocks. The fossils collected from the ferruginous beds have been determined by E. O. Ulrich to be of Mississippian age.

Three prospects were examined within a distance of about 1 mile along the strike of the beds. From 2 feet 7 inches to more than 8 feet of sandy, shaly ore were measured. The material had mostly been leached of its soluble constituents, thereby increasing the percentage of iron, and some of the iron had evidently been hydrated to limonite, or brown ore. The range in major constituents, according to seven analyses, two of which were made by the United States Geological Survey, was as follows: Metallic iron, 33.5 per cent to 40.5 per cent; silica, 14 per cent to 26.5 per cent; alumina, 7 per cent to 10 per cent; calcium oxide, 0 to 12 per cent; manganese, about 0.3 per cent; sulphur, about 0.1 per cent; phosphorus, 0.1 per cent to 0.25 per cent.

The uncertainty as the the quantity of this ore and its distance from a railroad (the nearest point is reported to be more than a mile distant) renders its present value doubtful.

SUMMARY OF IMPORTANT ORE-BEARING LOCALITIES.

Although relatively unimportant deposits of ore in the Tellico sandstone and the Grainger shale have been noted in this paper, such mention should not obscure the fact that the bedded "Rockwood" iron ore is to be regarded as the mainstay of the southern iron industry, and it has been thought best briefly to call attention once more to the areas carrying the most promising beds of ore.

In east Tennessee the areas of outcrop of "Rockwood" ore beds more than 2 feet thick (less than which thickness of ore can be worked profitably only by stripping) are distributed along the eastern edge of the coal field, and are widely separated by areas in which the ore is less than 2 feet thick. In a few places there are outcrops of ore east of Tennessee and Clinch rivers. These are known as valley areas, and contain beds that are also variable in thickness. In northeast Tennessee the workable ore occurs near La Follette and southwest of Cumberland Gap, with the possibility of the bed near Elk Valley proving of value. The available ore in northeast Tennessee may be considered as tributary to blast furnaces at La Follette, Tenn., and Middlesboro, Ky. In central east Tennessee there are not very long outcrops of workable ore but the beds are thicker here then elsewhere and support iron manufacturing establishments at Rockwood and Dayton. In southeast Tennessee the greater part of the ore outcrop falls below a thickness of 2 feet, although such beds as reach this thickness are near Chattanooga. There is no mining activity in Tennessee near Chattanooga at present. The ore beds locally developed are not of attractive thickness and have been pretty thoroughly mined by stripping on the outcrop. Southward from Chattanooga, however, as these beds are traced into Alabama and Georgia, along opposite sides of Lookout Mountain, their thickness is found to increase, and there is a considerable extent of hard ore near Trenton, Ga., in Lookout Valley and Pudding Ridge, also under Pigeon Mountain near Estelle, that can be brought to Chattanooga furnaces at a low cost both for mining and transportation. In fact the transportation problem is much simpler for ores south of Chattanooga than it is for supplies from the State of Tennessee. Farther southwest, beyond Trenton and Estelle, Ga., there are bodies of ore that have been mined and shipped to Chattanooga. On the west side of Lookout Mountain they extend as far as Attalla, Ala., and on the east side of the Lookout area they extend to Gadsden, Ala., and comprise not only the area outcropping at the base of the mountain, but such valley outcrops as those of the Dirtseller and the Taylor Ridge areas.

It is evident that the greater part of the red ore to supply the iron industry at Chattanooga will come logically from neighboring areas in northwest Georgia and northeast Alabama, although blast furnaces in these areas will also continue to draw on local supplies of ore. The coke furnaces at Battelle, Ala., and Rising Fawn, Ga., and the charcoal furnaces at Attalla, Ala., and at Cedartown, and Rome, Ga., are idle at present, and the coke furnaces at Gadsden are shut

down temporarily, but the one at Alabama City, Ala., is active and is providing molten iron for the manufacture of steel and steel products at Alabama City.

This paper has not treated of the brown ore that forms such an important part of the furnace burdens in the South, but it is well known that such deposits are becoming depleted and that new supplies are not being discovered as fast as the known supply is being exhausted. It is only a question of time, therefore, when this useful type of ore, practically will have disappeared from the market, although, of course, that time is relatively remote. As brown ore becomes more difficult to obtain the red ore of the Taylor Ridge and Dirtseller type containing high percentage of iron with lower lime and higher silica than ores farther west will come more into demand for mixing with the leaner and more limy red ore of the Trenton-Pudding Ridge type. For a time the residual Tellico ore near Sweetwater may also contribute to the supply of high-silica ore. The hard ore near Estelle promises to be a valuable resource also.

The following table presents a few typical working analyses of hard and soft "Rockwood" iron ores from mines in east Tennessee, northeast Alabama, and northwest Georgia:

Analyses of "Rockwood" iron ore from Tennessee, Alabama, and Georgia.

Locality.	Authority. [a]	Fe.	SiO_2.	Al_2O_3.	CaO.	Mn.	P.	S.	H_2O.
East Tennessee:									
Hill City, hard ore	U. S.	27.30	6.21	3.20	26.53	0.056	0.227	0.068	.....
Hill City, soft ore	O.	57.50	10.26	1.61	.50	.46	.432	.....	3.45
Rockwood, hard ore	R.	36.13	5.81	3.83	16.66	.....	.083	.....	.....
Rockwood, soft ore	R.	47.27	13.10	6.70	.....	.....	.....	.....	.....
Chamberlain, hard ore	U. S.	28.20	5.60	2.82	24.84	.23	.431	.05	5.61
Chamberlain, soft ore	U. S.	52.45	7.62	4.31	.40	.23	.532	.02	10.01
Lafollette, hard ore	L.	26.30	10.24	8.30	15.89	.60	.61	None.	5.00
Lafollette, soft ore	L.	44.65	12.48	.....	.....	.....	.....	.....	.....
Northeast Alabama:									
Attalla, hard ore	C.	36.97	8.61	.....	16.56	.....	.50	.....	.....
Attalla, soft ore	C.	53.92	8.39	.....	.....	.....	.676	.....	.....
Citico, hard ore	C.	38.07	10.24	4.17	14.38	.14	.38	.....	.....
Northwest Georgia:									
Trenton, hard ore	O.	29.86	6.76	4.86	24.29	.....	.324	Tr.	.....
Estelle, semihard ore	U. S.	41.35	7.21	4.18	11.94	.....	.362	.099	.....
Hillsdale, soft ore	L.	48.70	15.80	6.40	.76	.....	.30	.10	.20

[a] Authorities: C, Citico Blast Furnace Co.; L, Lafollette Iron Co.; O, Owners of property; R, Roane Iron Co.; U. S., U. S. Geological Survey.

MINING DEVELOPMENT.

STAGES OF DEVELOPMENT.

In the southern Appalachians the development of mining bedded iron ore is in two principal stages. The first stage consists in mining the ore on the outcrop, and the second stage consists in mining it from underground drifts and slopes. Open cut mining has been carried on along the outcrop practically wherever the ore has been found thick enough to be dug and shipped to market without entailing financial loss. Only in areas remote from the railways or where the ore is very thin, are there no traces of former stripping operations. Stripping of the ore beds was done by hand, and by scrapers drawn by horses or mules, and was carried to as great depths as was found to be profitable, depending on the thickness and quality of the ore

bed, its dip, and on the character of the overlying rock. A maximum thickness of 30 feet of stripping was observed at one place. The overlying shale is often found to be so hard that it is necessary to blast it out, after which the loosened material is shoveled into wagons and hauled out of the way. Few of the old strip pits now show their former maximum depth since they are partly filled by slumping down of the wall, and in many places the shale has been "back filled" where the ore was removed. This phase of the iron mining industry is now nearly obsolete, because of the exhaustion in most areas of the reserves of soft ore near the surface. Some of the old trenches and embankments that are encountered in the woods while following the outcrop of the ore beds are of considerable age, as is indicated by the size of the forest trees that have grown over them since mining was abandoned. In the Chamberlain district, Tennessee, open-cut mining is still in progress on a considerable scale.

Underground mining has succeeded surface mining generally where the ore beds are of attractive quality and of more than the average thickness, or else are so situated that the cost of transportation to blast furnaces is relatively low. This does not necessarily imply that the ore is now being mined underground at all localities at which it is available, for there are in Tennessee, Alabama, and Georgia several well-located areas underlain by good "Rockwood" ore that are not yet under development.

A further stage to which mining of bedded iron ore may eventually progress is that of shaft mining. This would possibly be the most practicable method of working the ore below the Cumberland Plateau, if it is ever mined there. In the area between Lafollette and Elk Valley and also northwest of the Rockwood-Cardiff strip, the "Rockwood" ore is probably of workable thickness although very deep below the surface. No shaft mining of "Rockwood" ore has yet been attempted in the South, but it is reported that a 50° slope is being sunk to an ore bed 1,900 feet below the surface, near Oxmoor, Ala., and the results of this work will be watched with close attention by everyone interested in the development of southern iron-ore fields.

CONDITIONS AFFECTING UNDERGROUND MINING.

A summary of the most important points to be considered in relation to underground mining of bedded iron ore in the South would include (*a*) thickness of beds, (*b*) quality of ore, (*c*) attitude and structure of beds, (*d*) relation to topography and water level, (*e*) continuation of ore with depth, (*f*) distance from transportation routes, (*g*) relation to markets. The question of markets in the area under consideration is not at present serious, since the blast furnaces at Chattanooga, Dayton Rockwood, and Lafollette, Tenn., Gadsden, and Attalla, Ala., and at Rome, Ga., are generally, when in blast, willing to buy ore at market prices.

With regard to the minimum workable thickness, the poorest acceptable quality, and the other limitations that may be imposed by the various factors mentioned above, it may be said that all are more or less interdependent. For instance, a very rich ore can be worked in thinner and more disturbed beds than can a lean ore. A rich and thick ore bed whose extent is known to be limited by a fault may not warrant the outlay necessary for a railway spur and the necessary mining equipment which a thinner and leaner bed whose

extent has been proved by prospecting to be much greater may warrant. Except in the case of the ore beds near Ooltewah, which are worked in a small way for paint material, the writer has observed in the southern region no extensive underground mining of beds whose thickness averaged less than 2 feet, nor does self-fluxing ore carrying less than an average of 25 per cent of metallic iron seem to be considered minable. In fact, no one acquainted with iron making in the South would at present be likely to become enthusiastic over mining a 2-foot bed of ore averaging 25 per cent of metallic iron, no matter how extensive or easily accessible it might be. With changing conditions, however, such an ore bed may become of considerable value at some future time, and for this reason it was thought best to include mention of the outcrop of such beds in this bulletin.

As to the maximum distance down the dip, measured from the outcrop, or the maximum vertical depth below the level of the outcrop, to which an ore bed may profitably be worked, it should also be stated that these limits are greatly affected by other factors. In some slopes where the ore is thin or of poor quality, the limit of workability under present conditions has already been reached, and mining has been discontinued. Probably when the price of ore has risen sufficiently some of these slopes may be reopened. Other slopes that are driven in fairly thick ore of good quality have penetrated to far greater distances than the abandoned slopes and are still being operated at a profit. Obviously no workable limit can be applied to ore in such localities. For the purpose of making hasty approximations as to the tonnage of iron ore available in the Chattanooga district [1] in 1908, a vertical depth of 1,000 feet was taken as an arbitrary limit to which the bedded iron ore in east Tennessee might be considered available under conditions prevailing at that time. No active slope had then reached more than half that vertical depth and some had been abandoned at much less depths. Although less than five years have elapsed since the above-mentioned estimates were made, one would now hesitate to place a workable limit at 1,500 feet or even at 2,000 feet vertically below the surface. It is therefore evident that the workable limit of ore in depth is a rapidly progressing factor, and one which can not be assumed with any degree of certainty in making estimates of ore reserves.

The question has often been asked as to what extent surface conditions can be depended upon to indicate the thickness, quality, continuity, and structure of the ore bed beneath the surface. Surface conditions in regard to the quality of an ore bed, provided it has been prospected back to the hard ore, are generally reliable. If prospect pits, extending a sufficient distance along the outcrop, have disclosed hard ore of uniformly good quality, it may reasonably be assumed that the bed will continue below the surface with but little deterioration. A few exceptions to this rule have, however, been noted. The variations in quality and thickness along the outcrop should be carefully noted. Variations are characteristically more abrupt in the direction of the dip than along the strike of the ore beds. The structure of the beds overlying the ore should be noted carefully, since there naturally exists a certain parallelism in structure between surface and underlying beds. Faults, or dislocations in the strata,

[1] Burchard, E. F., Tonnage estimates of Clinton iron ore in the Chattanooga region: Bull. U. S. Geol. Survey No. 380, 1909, pp. 169–187.

should be carefully noted, and it should at once be determined whether the beds beyond the fault have moved relatively up or down. If those beds have moved upward, was the upthrow sufficient to bring the ore bed above the surface and thereby terminate its extent in that immediate vicinity? If the rocks beyond the fault were dropped, instead, to what depth is the ore depressed? To what depth has the ore dipped below a given point on the surface? These questions can perhaps be answered by careful geological study, but it may require deep drilling to definitely settle such points. The writer has in mind an instance where, had the geological evidence been given due weight, much expense and futile search for ore might have been avoided. At the outcrop the ore dipped at a moderate angle, and conditions were evidently favorable for the driving of a slope, but at a few hundred feet beyond the outcrop, in the direction of the dip, an abrupt change occurred in the surface rocks. An area of nonfossiliferous chert and dolomite was adjacent to a highly fossiliferous chert which lay above the ore-bearing formation. The fossiliferous beds were those of the Fort Payne chert, which normally lie 150 to 200 feet above the iron ore; the nonfossiliferous ones were those of the Knox dolomite, which normally lies many hundreds of feet below the ore. No attention was paid to these geological conditions, however, but a slope was driven and elaborate preparations were made for mining. Within a few hundred feet the slope ran into broken ground and the ore was lost. Two other slopes were driven, both of which encountered the same difficulties. The conditions were plain enough, but instead of heeding them the owners drilled a hole nearly 1,000 feet deep in search of the ores in the Knox dolomite. Thorough deep drilling, in the right place, is most strongly recommended, but it should be ascertained before beginning whether the proposed drilling is to start in beds above or below the ore horizon. Too little drilling has thus far been done in the ore fields, probably because of the great expense, but the expense is generally well justified, by the information yielded concerning depth to ore, thickness and quality of ore, dip of the beds, etc., provided a preliminary geological study is made so that the drill hole is judiciously located.

The great extent to which the soft ore beds were formerly worked at the surface is one of the factors that has led to the greatest misapprehension concerning southern iron ores in general. To persons engaged in pursuits wholly unrelated to mining, but who may be interested in mineral lands from the surface of which there was produced 20 to 50 years ago a considerable tonnage of rich ore, it naturally appears reasonable to believe that this mining activity should at some future time be revived. It should be necessary only to recall two points in this connection. First, surface mining is the cheapest method of working the ore beds; it requires comparatively little outlay for equipment, and it can be terminated and the outfit moved away without great loss when the work becomes unprofitable. Second, the soft ore, which was obtainable at the surface, was much richer in metallic iron than the hard ore which is to be expected below ground-water level. If these two points are borne in mind it will readily be seen that to be workable underground a hard ore bed must have a thickness much greater than the 6-inch to 18-inch seams that were formerly stripped and trenched for many miles along their outcrop in the southern Appalachian region.

IRON AND STEEL INDUSTRY OF THE UNITED STATES.[1]

PRODUCTION, SALES, AND VALUE OF PIG IRON BY STATES.

According to the Bureau of Statistics of the American Iron and Steel Institute, which is continuing the statistical work of the former American Iron and Steel Association, the production of all kinds of pig iron including such ferro-alloys as spiegeleisen, ferromanganese, ferrosilicon, ferrophosphorus, etc., in 1912 was 29,726,937 long tons, compared with 23,649,547 tons produced in 1911, an increase of 6,077,390 tons, or 25.7 per cent.

The following table gives the production of all kinds of pig iron, by States, in 1911 and 1912, according to their rank in each year:

Production of pig iron, by States, in long tons.[a]

States.	1911			States.	1912		
	Rank.	Quantity.	Per centage.		Rank.	Quantity.	Per centage.
Pennsylvania	1	9,807,073	41.47	Pennsylvania	1	12,552,131	42.23
Ohio	2	5,310,506	22.46	Ohio	2	6,802,493	22.88
Illinois	3	2,108,002	8.91	Illinois	3	2,887,359	9.71
Alabama	4	1,712,211	7.24	New York	4	1,939,231	6.52
New York	5	1,562,756	6.61	Alabama	5	1,862,681	6.27
Indiana, Michigan	6	1,163,932	4.92	Indiana, Michigan	6	1,770,628	5.96
Missouri, Colorado, California	7	395,968	1.68	Missouri, Colorado, California	7	397,731	1.34
Tennessee	8	324,648	1.37	Tennessee	8	338,238	1.14
Virginia	9	293,642	1.24	Wisconsin, Minnesota	9	303,370	1.02
West Virginia	10	291,472	1.23	West Virginia	10	274,360	.92
Wisconsin, Minnesota	11	276,807	1.17	Virginia	11	256,167	.86
Maryland	12	255,816	1.08	Maryland	12	219,546	.74
Kentucky	13	95,202	.40	Kentucky	13	68,760	.23
New Jersey	14	40,663	.17	New Jersey	14	36,876	.12
Connecticut, Massachusetts	15	9,649	.04	Connecticut, Massachusetts	15	17,366	.06
Georgia, Texas	16	1,200	.01	Georgia, Texas	16	.....	.....
Total	.....	23,649,547	100.00	Total	.....	29,726,937	100.00

[a] Bureau of Statistics of the American Iron and Steel Institute.

Although the United States Geological Survey accepts as official the statistics of production of pig iron and ferro-alloys heretofore collected by the American Iron and Steel Association and, beginning with the last half of 1912, by the American Iron and Steel Institute, it has been found necessary for the Survey to make a statistical canvass of the pig-iron manufacturing industry in order to obtain the value of the product, the data for which can be obtained in no other way. It should be explained here that the only common term in which the production of diversified mineral products may be expressed is that of value, at the mine, quarry, or manufacturing plant, and in order that the mineral production of the United States may be summarized the value of each product must be obtained. It has been found more accurate and convenient to obtain the value of the pig iron corresponding to the tonnage sold rather than that

[1] The statistics for all steel production and the pig iron statistics, except those of marketed production, have been collected and published in the annual reports of the American Iron and Steel Association to 1911; those for 1912 are according to the American Iron and Steel Institute.

corresponding to the actual production in a given year, and thus in collecting and publishing the statistics of quantity and value of marketed production of pig iron the Survey is not duplicating the labors of the American Iron and Steel Institute but, instead, is presenting additional data to the iron trade—data that are available only to the Survey.

The marketed production of pig iron in 1912 amounted to 30,180,969 long tons, valued f. o. b. at the furnaces at $420,563,388, as compared with 23,257,288 long tons, valued at $327,334,624, in 1911, an increase in quantity of 6,923,681 tons, or 29.8 per cent, and in value of $93,228,764, or 28.5 per cent. The average price per ton in 1912 was $13.93, and in 1911 it was $14.07, a decrease in 1912 of 14 cents a ton. The figures of pig iron marketed given for 1911 and 1912 were collected by the United States Geological Survey. The values of pig iron for 1907, 1908, 1910, 1911, and 1912 were reported to the United States Geological Survey by the manufacturers and represent the approximate price per ton f. o. b. at the furnaces; this approximate price eliminates freight costs, commissions, etc., which are included in the market prices of pig iron as published in the trade journals. The value for 1909 is an estimate made on a basis similar to that used in estimating the values prior to 1907. The marketed production of pig iron includes the metal produced from foreign as well as domestic ore. The quantity and value of blast-furnace products derived from ore imported from Cuba, Sweden, Spain, Newfoundland, Nova Scotia, Labrador, Canada, Brazil, Venezuela, Russia, Greece, and Algeria, although it constitutes a very small percentage of the total production, is considerable, as the sales of pig iron alone, derived from foreign ore, amounted in 1912 to 1,199,774 long tons, valued at $18,184,935, compared with 953,685 long tons, valued at $14,000,066, in 1911.

The following table shows the quantity and value of pig iron, exclusive of ferro-alloys, marketed in the United States in 1911 and 1912, by States, together with the increase and percentage of increase in 1912:

Quantity and value of pig iron marketed in the United States in 1911 and 1912, by States, with increase and percentage of increase in 1912, in long tons.

State.	1911		1912		Increase in 1912.		Percentage of increase in 1912.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	1,617,150	$17,379,171	1,987,753	$21,371,053	370,603	$3,991,882	22.92	22.97
Illinois	2,036,081	31,152,927	2,806,378	42,828,816	770,297	11,675,889	37.83	37.48
Kentucky	57,982	870,542	77,578	1,221,161	19,596	350,619	33.80	40.28
Michigan	304,654	4,672,799	459,975	6,579,048	155,321	1,906,249	50.98	40.79
New York	1,537,201	23,924,194	1,973,090	28,059,058	435,889	4,134,864	28.36	17.28
Ohio	5,371,378	73,484,592	7,127,176	93,140,369	1,755,798	19,655,777	32.69	26.75
Pennsylvania	9,581,109	136,328,507	12,437,685	181,569,299	2,856,576	45,240,792	29.81	33.19
Tennessee	297,594	3,439,644	339,397	4,171,153	41,803	731,509	14.05	21.27
Virginia	308,789	3,898,285	328,961	4,364,708	20,172	466,423	6.53	11.96
Wisconsin	245,152	3,803,049	270,981	3,883,125	25,829	80,076	10.54	2.11
Other States [a]	1,900,198	28,380,914	2,371,995	33,375,598	471,797	4,994,684	24.83	17.60
Total	23,257,288	327,334,624	30,180,969	420,563,388	6,923,681	93,228,764	29.77	28.48

[a] 1911: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1912: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia.

The following table gives the annual average price per long ton of pig iron in the United States for the years 1889 to 1912. The prices prior to 1907 include the cost of transportation from blast furnaces to markets. Prior to 1910 the values of ferro-alloys are included. The extreme range in prices, from $9.76 in 1894 to $20.92 in 1902, is of interest:

Average price per long ton of pig iron in the United States, 1889–1912.

1889	$15.78	1897	$9.85	1905	$16.63
1890	16.43	1898	9.90	1906	19.98
1891	15.50	1899	18.00	1907	20.56
1892	14.32	1900	18.85	1908	15.96
1893	11.90	1901	15.25	1909	16.25
1894	9.76	1902	20.92	1910	15.45
1895	11.14	1903	19.12	1911	14.07
1896	10.47	1904	14.13	1912	13.93

The average price of pig iron per long ton, by States, for 1910, 1911, and 1912 is given in the following table. This represents the price at the blast furnaces and does not include the prices of ferro-alloys.

Average price per long ton of pig iron in the United States, 1910 to 1912, by States.

State.	1910	1911	1912
Alabama	$12.25	$10.75	$10.75
Illinois	15.91	15.30	15.26
Kentucky	16.07	15.01	15.74
Michigan	16.62	15.34	14.30
New Jersey	15.88	(a)	(a)
New York	16.72	15.56	14.22
Ohio	15.29	13.68	13.07
Pennsylvania	15.84	14.23	14.60
Tennessee	12.99	11.56	12.29
Virginia	13.85	12.62	13.27
Wisconsin	15.77	15.51	14.33
Other States[b]	15.63	14.94	14.07
Total	15.45	14.07	13.93

[a] Included in "Other States."

[b] 1910: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1911: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1912: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia.

BLAST FURNACES.

The following notes on the blast furnace situation in the United States at the close of 1912 are quoted from a recent publication of the American Iron and Steel Institute:[1]

Furnaces in blast.—The whole number of furnaces in blast on December 31, 1912, was 313, against 266 on June 30, 1912, and 231 on December 31, 1911. The number of furnaces idle on December 31, 1912, including furnaces being rebuilt, was 153, against 200 on June 30, 1912, and 235 on December 31, 1911.

During the last six months of 1912 the number of furnaces actually in blast during a part of the whole of the period was 337, against 302 in the first half of the year. In the last half of 1911 275 furnaces were active, against 297 in the first half.

[1] Statistical Bull. No. 1, Bur. Statistics, Am. Iron and Steel Inst., 1913, Jan. 30.

Furnaces building.—On December 31, 1912, there were 7 entirely new furnaces in course of construction, all of which will use mineral fuel, as follows: Pennsylvania, 3; Virginia, 1; Ohio, 1; and Minnesota, 2. In addition 1 coke furnace in Virginia was partly erected but work had been suspended for several years.

Furnaces rebuilding.—On December 31, 1912, 8 old furnaces were being rebuilt, all mineral fuel, as follows: New Jersey, 1; Pennsylvania, 1; Maryand, 1; Virginia, 1; Alabama, 1; and Ohio, 3.

New furnaces.—During the last six months of 1912, but one entirely new furnace was completed, namely, the charcoal furnace of the Stephenson Charcoal Iron Co., at Wells, Mich. It has an annual capacity of 20,000 tons.

Furnaces abandoned.—In the last half of 1912 Tallapoosa furnace, at Tallapoosa, Ga., was abandoned. The furnace used charcoal for fuel when last in blast and had an annual capacity of 13,500 tons. During the first half of the year 7 furnaces, with an annual capacity of 215,000 tons, were abandoned, all of which used mineral fuel when last in blast.

The following table shows the number of blast furnaces in blast on June 30 and December 31 and the total number of stacks recorded for the years 1911 and 1912, but does not of course include the electric reduction furnace at Heroult, Cal.:

Record of blast furnaces in the United States, 1911 and 1912, by States.[a]

State.	Furnaces in blast June 30, 1911.	Dec. 31, 1911.			Furnaces in blast June 30, 1912.	Dec. 31, 1912.		
		In.	Out.	Total.		In.	Out.	Total.
Pennsylvania	81	91	73	164	108	128	35	163
Ohio	35	44	31	75	49	58	17	75
Illinois	16	14	10	24	20	22	4	26
Alabama	17	22	27	49	19	25	24	49
New York	15	13	16	29	17	19	10	29
Virginia	7	7	18	25	6	7	18	25
Tennessee	9	8	11	19	9	7	12	19
Colorado	3	3	3	6	3	3	3	6
Missouri	2	1	1	2	1	1	1	2
Oregon	0	0	1	1	0	0	1	1
Washington	0	0	1	1	0	0	1	1
California	0	0	0	0	0	0	0	0
Maryland	3	2	3	5	2	3	2	5
New Jersey	1	0	8	8	1	1	6	7
Wisconsin	2	4	3	7	3	5	2	7
Minnesota	1	0	1	1	1	1	0	1
Indiana	6	7	2	9	10	10	0	10
Michigan	7	8	8	16	10	12	4	16
West Virginia	3	3	1	4	2	3	1	4
Kentucky	3	2	6	8	1	3	5	8
Georgia	0	0	4	4	0	0	3	3
Texas	0	0	4	4	0	0	4	4
Connecticut	0	1	2	3	3	3	0	3
Massachusetts	1	1	1	2	1	2	0	2
Total	212	231	235	466	266	313	153	466

[a] Statistics of the American Iron and Steel Association for 1911 and the first six months of 1912, and of the Bureau of Statistics of the American Iron and Steel Institute for the last six months of 1912.

MONTHLY PRODUCTION OF PIG IRON.

The accompanying diagram (fig. 2) illustrates the course of the manufacture of pig iron by months during the last five years. The sudden decline in production of pig iron at the close of October, 1907, the low production during the first half of 1908, the slow recovery of

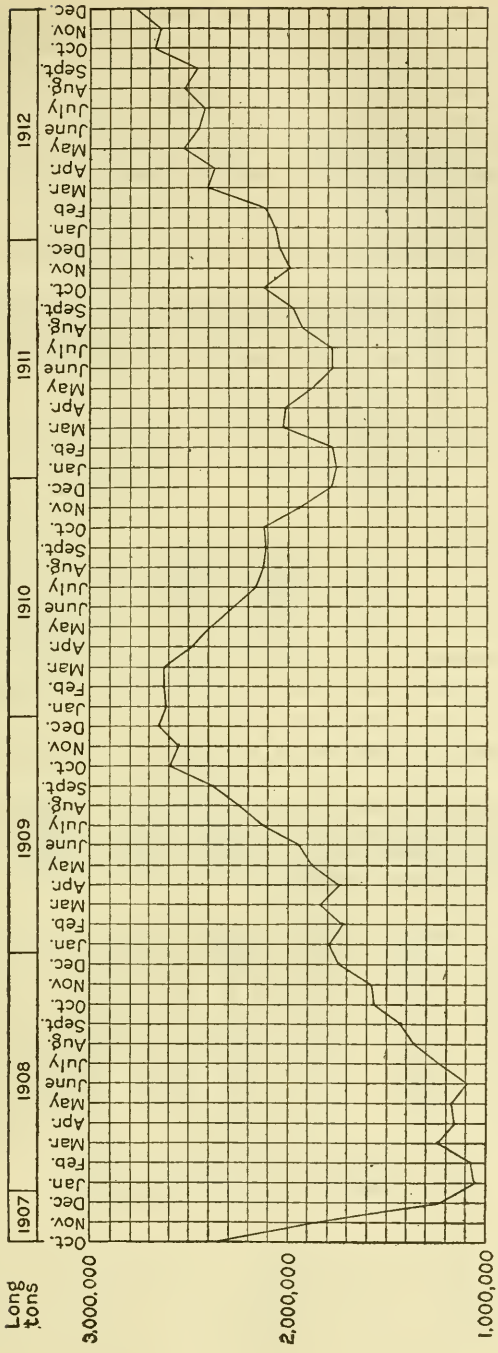

FIGURE 2.—Curve showing production of coke and anthracite pig iron in the United States from October, 1907, to December, 1912, by months. Tonnage according to the Iron Age, March 6, 1913.

activity in the last half of 1908, the hesitating conditions early in 1909, the steady and rapid increase in production during the last part of that year, culminating in December with a production of more than 2,682,000 tons, the gradual, almost uninterrupted, decline throughout the year 1910, the moderate production during 1911, broken by alternating declines and recoveries, and the steadily rising production of 1912, which at the close of the year surpassed that of any previous year, are graphically indicated.

PRODUCTION OF PIG IRON BY GRADES.

The following table shows the production of the principal grades of pig iron, from 1908 to 1911, inclusive, according to the statistics of the American Iron and Steel Association, and for 1912 according to the American Iron and Steel Institute:

Production of pig iron in the United States, 1908–1912, by grades, in long tons.

Grade.	1908	1909	1910	1911	1912
Bessemer and low phosphorus	7,216,976	10,557,370	11,245,642	9,409,303	11,664,015
Basic (mineral fuel)	4,010,144	8,250,225	9,084,608	8,520,020	11,417,886
Forge pig iron	457,164	725,624	564,157	408,841	469,183
Foundry and ferrosilicon	3,637,622	5,322,415	5,260,447	4,468,940	5,073,873
Malleable Bessemer	414,957	658,048	843,123	612,533	825,643
Spiegeleisen	111,376	142,831	153,055	110,236	96,346
Ferromanganese	40,642	82,209	71,376	74,482	125,378
White, mottled, direct castings, etc	47,137	56,749	81,159	45,192	54,613
Total	15,936,018	25,795,471	27,303,567	23,649,547	29,726,937

PRODUCTION OF PIG IRON ACCORDING TO FUEL USED.

In the following table are given the statistics of the American Iron and Steel Association showing the production of pig iron according to the fuel used, from 1908 to 1911, inclusive, and those of the American Iron and Steel Institute for 1912:

Production of pig iron according to fuel used, 1908–1912, in long tons.

Fuel used.	1908	1909	1910	1911	1912
Bituminous, chiefly coke	15,331,863	24,721,037	26,257,978	23,141,296	29,132,733
Anthracite and coke	353,315	682,383	628,579	212,548	236,467
Anthracite alone	1,694	16,048	20,503	17,027	10,712
Charcoal	249,146	376,003	396,507	278,676	347,025
Total	15,936,018	25,795,471	27,303,567	23,649,547	29,726,937

TOTAL PRODUCTION OF PIG IRON.

The following table shows the production of pig iron in the United States as far as has been recorded. The statistics for 1912 are those of the American Iron and Steel Institute; those for years from 1854 to 1911 were collected by the American Iron and Steel Association and include the production of the commoner ferro-alloys; those for 1810, 1840, and 1850 are census figures; those for the other years are largely estimates by early statisticians.

Production of pig iron in the United States, 1810–1912, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1810	53,908	1864	1,014,282	1889	7,603,642
1820	20,000	1865	831,770	1890	9,202,703
1828	130,000	1866	1,205,663	1891	8,279,870
1829	142,000	1867	1,305,023	1892	9,157,000
1830	165,000	1868	1,431,250	1893	7,124,502
1831	191,000	1869	1,711,287	1894	6,657,388
1832	200,000	1870	1,665,179	1895	9,446,308
1840	286,903	1871	1,706,793	1896	8,623,127
1842	215,000	1872	2,548,713	1897	9,652,680
1846	765,000	1873	2,560,963	1898	11,773,934
1847	800,000	1874	2,401,262	1899	13,620,703
1848	800,000	1875	2,023,733	1900	13,789,242
1849	650,000	1876	1,868,961	1901	15,878,354
1850	563,755	1877	2,066,594	1902	17,821,307
1852	500,000	1878	2,301,215	1903	18,009,252
1854	657,337	1879	2,741,853	1904	16,497,033
1855	700,159	1880	3,835,191	1905	22,992,380
1856	788,515	1881	4,144,254	1906	25,307,191
1857	712,640	1882	4,623,323	1907	25,781,361
1858	629,548	1883	4,595,510	1908	15,936,018
1859	750,560	1884	4,097,868	1909	25,795,471
1860	821,223	1885	4,044,526	1910	27,303,567
1861	653,164	1886	5,683,329	1911	23,649,547
1862	703,270	1887	6,417,148	1912	29,726,937
1863	846,075	1888	6,489,738		

PRICES OF PIG IRON.

In the following table are given the average monthly prices of the principal kinds of pig iron for 1911 and 1912:

Average monthly prices per ton of pig iron, 1911 and 1912, by months and kinds.

Month.	1911				1912			
	No. 2 foundry pig iron at Pittsburgh.[a]	Gray forge pig iron at Pittsburgh.[b]	Bessemer pig iron at Pittsburgh.[b]	Basic pig iron (eastern Pennsylvania and nearby points).[c]	No. 2 foundry pig iron at Pittsburgh.[a]	Gray forge pig iron at Pittsburgh.[b]	Bessemer pig iron at Pittsburgh.[b]	Basic pig iron (eastern Pennsylvania and nearby points).[c]
January	$14.75	$14.09	$15.90	$14.25	$14.00	$13.65	$15.15	$14.25
February	14.81	14.15	15.90	14.44	14.01	13.60	15.00	14.25
March	14.96	14.15	15.90	15.25	14.10	13.46	15.02	14.37
April	15.00	14.15	15.90	15.19	14.15	13.77	15.15	14.87
May	14.72	14.02	15.90	14.75	14.12	13.95	15.15	15.15
June	14.56	13.90	15.90	14.50	14.22	13.96	15.15	15.25
July	14.53	13.90	15.90	14.38	14.38	13.96	15.15	15.50
August	14.47	13.90	15.90	14.65	14.85	14.32	15.43	15.95
September	14.40	13.90	15.90	14.69	15.63	14.60	15.93	16.25
October	14.34	13.84	15.39	14.50	17.22	16.15	17.75	17.43
November	14.25	13.60	15.10	14.50	18.00	16.90	18.05	18.12
December	13.90	13.46	15.15	14.25	18.73	16.90	18.15	18.25

[a] Eng. and Min. Jour., Jan. 4, 1913, p. 48.
[b] Iron Trade Review, Jan. 4, 1912, and Jan. 2, 1913.
[c] Iron Age, Jan. 4, 1912, and Jan. 2, 1913.

The following table, compiled by the Iron Trade Review, summarizes the selling prices of Bessemer and Foundry No. 2 pig iron at the beginning of the buying season for the last 24 years:

Selling price of pig iron at date of buying movement.[a]

Season.	Date of buying movement.	Iron prices; Valley.	
		Bessemer.	Foundry iron No. 2.
1890	Dec. 15, 1889	$22.15	$18.15
1891	June 1, 1891	15.15	15.00
1892	Jan. 31, 1892	15.00	13.65
1893	Mar. 15, 1893	12.65	12.15
1894	Mar. 1, 1894	9.65	9.65
1895	Apr. 1, 1895	9.40	9.40
1896	May 1, 1896	12.40	11.15
1897	May 20, 1897	8.35	8.40
1898	Mar. 20, 1898	9.55	9.80
1899	Feb. 1, 1899	10.30	9.75
1900	Dec. 15, 1899	24.15	22.15
1901	Apr. 15, 1901	16.15	14.40
1902	Feb. 1, 1902	15.90	15.90
1903	Mar. 20, 1903	21.50	21.65
1904	Apr. 15, 1904	13.35	13.15
1905	Feb. 1, 1905	15.50	16.00
1906	Dec. 5, 1905	17.25	17.25
1907	Nov. 5, 1906	21.50	21.50
1908	June 15, 1908	16.00	15.00
1909	May 10, 1909	14.75	14.25
1910	Dec. 24, 1909	19.00	17.25
1911	Apr. 21, 1911	15.00	13.75
1912	Mar. 20, 1912	14.25	13.25
1913	Nov. 19, 1912	17.25	17.50

[a] Iron Trade Review.

FERRO-ALLOYS.[1]

PRODUCTION.

The United States Geological Survey undertook for the first time in the iron report for 1911 to present the statistics of production of ferro-alloys separately from those of pig iron, with which they have been heretofore included. Although the quantity of ferro-alloys is small, amounting to only about 1.09 per cent of the total marketed production of pig iron during the year, the value per ton is so much greater as to have an important influence on the apparent value of the pig iron if included with it; therefore it has been decided to separate the two subjects. There is a sufficient number of producers of the commoner ferro-alloys, such as ferromanganese and spiegeleisen, ferrosilicon and ferrophosphorus, to give the production of these two groups of alloys separately; but the production of the rarer alloys, such as ferromolybdenum, ferrotitanium, ferrotungsten, and ferrovanadium, must be grouped together. It should also be stated that the values of the first two groups of ferro-alloys have been in part estimated by the Survey for 1911 and almost entirely so for 1912.

The total marketed production of ferro-alloys in 1912 as reported to the United States Geological Survey was 328,685 long tons, valued at $12,223,776, compared with 253,375 long tons, valued at $8,377,832,

[1] Notes on manganese ferro-alloys are given in the chapter on the production of manganese and manganiferous ores in Mineral Resources for 1912.

in 1911. Of the production in 1912, 128,622 long tons, valued at $8,359,114, were made from imported ores derived from Australia, Portugal, India, and Peru. The ferrovanadium, ferromolybdenum, ferromanganese, ferrotitanium, and ferrotungsten were made wholly or in part from imported ore. The quantity reported does not represent the total production of the United States, as the production of considerable quantities of electrically produced ferro-alloys were not reported to the Survey.

The sales of ferromanganese and spiegeleisen in 1912 amounted to 227,939 long tons, valued at $8,282,006, compared with 178,615 long tons, valued at $4,746,541, marketed in 1911. The sales of ferrosilicon and ferrophosphorus in 1912 amounted to 97,371 long tons, valued at $1,795,707, compared with 70,122 long tons, valued at $1,345,884, in 1911. This represented a large increase in quantity and value for both groups of ferro-alloys, as compared with the production of 1911, and the figures for 1912 exceeded also those for 1910. The sales of alloys of iron with the rarer metals, molybdenum, titanium, tungsten, and vanadium, amounted in 1912 to 3,375 long tons, valued at $2,146,063, compared with 4,638 long tons, valued at $2,285,407, in 1911, thus showing a decrease in quantity of 1,263 long tons, and in value of $139,344. These alloys were therefore valued at an average price of nearly $636 per ton in 1912, compared with $493 per ton in 1911. Of this total the quantity of ferro-titanium predominated.

The following table gives a partial outline of the ferro-alloy sales in in the United States in 1910, 1911, and 1912:

Marketed production of ferro-alloys in 1910, 1911, and 1912, in long tons.

Kind of alloy.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ferromanganese and spiegeleisen	226,216	$6,011,723	178,615	$4,746,541	227,939	$8,282,006
Ferrosilicon and ferrophosphorus	62,647	1,411,779	70,122	1,345,884	97,371	1,795,707
Ferromolybdenum						
Ferrotitanium (10 to 20 per cent titanium)						
Ferrovanadium	(a)	(a)	4,638	2,285,407	3,375	2,146,063
Ferrotungsten (about 50 per cent tungsten)						
Other						
Total	288,863	7,423,502	253,375	8,377,832	328,685	12,223,776

a Not collected for 1910 by United States Geological Survey.

IMPORTS.

According to the Bureau of Foreign and Domestic Commerce, the imports for consumption of ferromanganese into the United States in 1912 were 99,137 long tons, valued at $3,906,920, as compared with 80,263 long tons, valued at $3,015,062, in 1911, and those of spiegeleisen in 1912 were 1,015 long tons, valued at $28,094, as compared with 20,970 long tons, valued at $405,444, in 1911. The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochrome are combined with those of chromium; those of ferromolybdenum are combined with those of the metal molybdenum; and those of ferrotungsten are included with

those of tungsten. For the sake of comparison, however, such statistics as are available are presented in the following table:

Imports of ferro-alloys in 1910, 1911, and 1912, in long tons.

Ferro-alloy.	Value per ton.	1910		1911		1912	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Chrome or chromium and ferrochrome.	$200 or less	446	$41,090	240.03	$20,173	436	$47,179
	More than $200	53	38,339	13.50	7,729	38	30,408
Total		499	79,429	253.53	27,902	474	77,587
Ferrophosphorus	$200 or less	146	5,171	186.13	8,520	103	4,465
Ferrosilicon	15 per cent or less silicon.	2,240	44,115				
	More than 15 per cent silicon.	9,152.14	483,042	6,658.00	341,681	7,490	446,456
Total		11,392.14	527,157				
Ferrovanadium	More than $200			1.07	2,623		
Molybdenum and ferromolybdenum.	do	9.04	14,402	8.50	11,409	4	4,670
Titanium and ferrotitanium.	$200 or less	1.04	260	.69	97	7	306
	More than $200	1.00	507	45.00	22,403	16	7,325
Total		2.04	767	45.69	22,500	23	7,631
Tungsten and ferrotungsten.	More than $200	528	678,534	115.07	143,802	288	323,872
Ferromanganese		114,228	4,341,071	80,263	3,015,062	99,137	3,906,920
Spiegeleisen		25,383	489,049	20,970	405,444	1,015	28,094

PRODUCTION OF STEEL BY STATES AND KINDS.

The following five tables show the production of the various steels, according to the statistical report for 1911 of the American Iron and Steel Association and that for 1912 of the American Iron and Steel Institute. The production of Bessemer steel ingots and castings in the leading States from 1908 to 1912 was as follows:

Production of Bessemer steel ingots and castings, 1908–1912, by States, in long tons.

State.	1908	1909	1910	1911	1912
Ohio	1,955,446	3,466,077	3,314,053	3,268,994	4,285,673
Pennsylvania	2,106,382	2,845,602	2,975,750	2,338,813	3,157,928
Illinois	1,237,747	1,632,444	1,693,053	1,335,053	1,559,576
Other States	817,180	1,386,660	1,429,916	1,004,994	1,324,724
Total	6,116,755	9,330,783	9,412,772	7,947,854	10,327,901

In the following table is given the production of open-hearth steel ingots and castings in the leading States from 1908 to 1912:

Production of open-hearth steel ingots and castings, 1908–1912, by States, in long tons.

State.	1908	1909	1910	1911	1912
New England States	158,417	257,392	223,158	189,879	214,325
New York and New Jersey	350,348	618,117	713,245	679,152	792,201
Pennsylvania	5,322,229	9,400,287	10,153,816	9,594,914	12,408,109
Ohio	525,171	1,424,452	1,733,409	1,721,549	2,565,343
Indiana	167,299	783,957	1,307,129	1,394,520	2,001,937
Illinois	483,104	1,052,572	995,011	801,624	1,235,166
Other States	830,161	957,159	1,378,741	1,217,012	1,563,642
Total	7,836,729	14,493,936	16,504,509	15,598,650	20,780,723

The following table gives the production, by States, of basic and acid open-hearth steel ingots and castings in 1911 and 1912:

Production of basic and acid open-hearth steel ingots and castings in 1911 and 1912, by States, in long tons.

State.	1911			1912		
	Basic open-hearth steel.	Acid open-hearth steel.	Total.	Basic open-hearth steel.	Acid open-hearth steel.	Total.
New England States	155,488	34,391	189,879	158,482	55,843	214,325
New York and New Jersey	630,421	48,731	679,152	712,998	79,203	792,201
Pennsylvania	8,913,868	681,046	9,594,914	11,556,362	851,747	12,408,109
Ohio	1,670,481	51,068	1,721,549	2,521,086	44,257	2,565,343
Indiana	1,371,614	22,906	1,394,520	1,965,003	36,934	2,001,937
Illinois	767,383	34,241	801,624	1,217,775	17,391	1,235,166
Other States	1,176,677	40,335	1,217,012	1,509,796	53,846	1,563,642
Total	14,685,932	912,718	15,598,650	19,641,502	1,139,221	20,780,723

The following table gives the production by States and by processes of all kinds of steel ingots and castings in 1911 and 1912:

Production of all kinds of steel ingots and castings in 1911 and 1912, by States, in long tons.

State.	1911				1912			
	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.
Massachusetts, Rhode Island, and Connecticut [a]	1,411	189,879	20,004	211,294	1,766	214,325	4,218	220,309
New York and New Jersey	355,717	679,152	34,692	1,069,561	514,657	792,201	42,628	1,349,486
Pennsylvania	2,338,813	9,594,914	56,796	11,990,523	3,157,928	12,408,109	67,717	15,633,754
Delaware, Maryland, District of Columbia, Virginia, West Virginia, Kentucky, Tennessee, Georgia, Alabama, Louisiana, and Texas	529,799	764,934	100	1,294,833	695,846	1,011,636	1,150	1,708,632
Ohio	3,268,994	1,721,549	3,567	4,994,110	4,285,673	2,565,343	5,013	6,856,029
Indiana and Illinois	1,335,053	2,196,144	7,596	3,538,793	1,559,576	3,237,103	12,009	4,808,688
Other States [b]	118,067	452,078	6,847	576,992	112,455	552,006	9,944	674,405
Total	7,947,854	15,598,650	129,602	23,676,106	10,327,901	20,780,723	142,679	31,251,303

[a] Figures for 1911 include Maine.
[b] Figures for 1912 include Canal Zone.

PRODUCTION OF ELECTRIC AND MISCELLANEOUS STEEL.

Statistics of the American Iron and Steel Association and the American Iron and Steel Institute show that the total electric production of steel in 1912 was 18,309 long tons, as compared with 29,105 tons in 1911, a decrease of 10,796 tons. In 1912 there were 13 plants which made steel by the electric process, as follows: Massachusetts, 1; New York, 3; Pennsylvania, 4; Indiana, 1; Illinois, 2; and Michigan, 2; as compared with a total of 9 plants in 1911, as follows: Massachusetts, 1; New York, 3; Pennsylvania, 3; Indiana, 1; and Illinois, 1. In 1912 about 14,147 tons were ingots and about 4,162 tons were castings,

and in 1911 about 27,227 tons were ingots and about 1,878 tons were castings. The total production of electric steel in 1912 includes about 9,609 tons of alloy steel ingots and castings, of which about 9,217 tons were ingots and about 392 tons were castings. In 1911 the production of electric alloy steel was about 6,722 tons, of which 6,612 tons were ingots and 110 tons were castings.

TOTAL PRODUCTION OF STEEL.

The statistics of the production of various kinds of steel, so far as has been recorded, are given in the following table:

Production of steel in the United States, 1810–1912, in long tons.

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1810	.....	.....	917		917
1860	.....	.....	11,838		11,838
1863	.....	.....	8,075		8,075
1864	.....	.....	9,258		9,258
1865	.....	.....	13,627		13,627
1866	.....	.....	16,940		16,940
1867	2,679	.....	16,964		19,643
1868	7,589	.....	19,197		26,786
1869	10,714	893	19,643		31,250
1870	37,500	1,339	29,911		68,750
1871	40,179	1,785	31,250		73,214
1872	107,239	2,679	26,125	6,911	142,954
1873	152,368	3,125	31,059	12,244	198,796
1874	171,369	6,250	32,436	5,672	215,727
1875	335,283	8,080	35,180	11,256	389,799
1876	469,639	19,187	35,163	9,202	533,191
1877	500,524	22,349	36,098	10,647	569,618
1878	653,773	32,255	38,309	7,640	731,977
1879	829,439	50,259	50,696	4,879	935,273
1880	1,074,262	100,851	64,664	7,558	1,247,335
1881	1,374,247	131,202	80,145	2,720	1,588,314
1882	1,514,687	143,341	75,973	2,691	1,736,692
1883	1,477,345	119,356	71,835	4,999	1,673,535
1884	1,375,531	117,515	53,270	4,563	1,550,879
1885	1,519,430	133,376	57,599	1,515	1,711,920
1886	2,269,190	218,973	71,973	2,367	2,562,503
1887	2,936,033	322,069	75,375	5,594	3,339,071
1888	2,511,161	314,318	70,279	3,682	2,899,440
1889	2,930,204	374,543	75,865	5,120	3,385,732
1890	3,688,871	513,232	71,175	3,793	4,277,071
1891	3,247,417	579,753	72,586	4,484	3,904,240
1892	4,168,435	669,889	84,709	4,548	4,927,581
1893	3,215,686	737,890	63,613	2,806	4,019,995
1894	3,571,313	784,936	51,702	4,081	4,412,032
1895	4,909,128	1,137,182	67,666	858	6,114,834
1896	3,919,906	1,298,700	60,689	2,394	5,281,689
1897	5,475,315	1,608,671	69,959	3,012	7,156,957
1898	6,609,017	2,230,292	89,747	3,801	8,932,857
1899	7,586,354	2,947,316	101,213	4,974	10,639,857
1900	6,684,770	3,398,135	100,562	4,862	10,188,329
1901	8,713,302	4,656,309	98,513	5,471	13,473,595
1902	9,138,363	5,687,729	112,772	8,386	14,947,250
1903	8,592,829	5,829,911	102,434	9,804	14,534,978
1904	7,859,140	5,908,166	83,391	9,190	13,859,887
1905	10,941,375	8,971,376	102,233	8,963	20,023,947
1906	12,275,830	10,980,413	127,513	14,380	23,398,136
1907	11,667,549	11,549,736	131,234	14,075	23,362,594
1908	6,116,755	7,836,729	63,631	6,132	14,023,247
1909	9,330,783	14,493,936	107,355	22,947	23,955,021
1910	9,412,772	16,504,509	122,303	55,335	26,094,919
1911	7,947,854	15,598,650	97,653	31,949	23,676,106
1912	10,327,901	20,780,723	121,517	21,162	31,251,303

MANGANESE AND MANGANIFEROUS ORES.

By D. F. Hewett.

INTRODUCTION.

The production of manganese and manganiferous ores in 1912 presented several important features. The domestic production of manganese ore was the lowest in 30 years, except that of 1909, whereas the imports were the greatest thus far recorded. At the same time the quoted prices paid for ores were reduced below those which have prevailed for several years, the only explanation for this reduction being that conditions favorable to high production were maintained during the year in the countries that are the principal sources of the world's supply.

Further, the price of ferromanganese reached its highest point since 1904, the period of the Russo-Japanese war. This great rise in price has been attributed [1] to the increased production of steel, but the increase in price appears out of proportion to the increase of production of steel.

The demand of the steel industry of the United States for manganese is now so great, as compared with that of 20 years ago, that it is extremely doubtful whether the future demand can be supplied from domestic sources, and, unless important changes in import duties are made, prices paid for ores will undoubtedly depend on conditions in the countries that now produce them.

SOURCES OF MANGANESE.

Manganese minerals.—For commercial purposes materials containing manganese are separated into four classes: (1) Manganese ores, (2) manganiferous iron ores, (3) manganiferous silver ores, and (4) manganiferous zinc residuum. This classification is based on the character of the materials now available in the United States and is due largely to the nature of the deposits, and as it is purely commercial it may be incomplete if applied to resources in foreign countries, or it may contain superfluous classes. Thus the United States alone possesses large deposits of franklinite, which when roasted yields manganiferous zinc residuum. Though manganese forms a part of about a hundred minerals and is a relatively widespread element, practically all the manganese of commerce is derived from material containing one or more of the first seven of the minerals named in the following table.[2]

[1] The position of manganese; Iron Age, Nov. 14, 1912, p. 1167.

[2] For details concerning manganese minerals the reader is referred to a recent exceptionally complete and valuable work by L. Leigh Fermor: The manganese ore deposits of India, Memoirs of the Geological Survey of India, vol. 37, pt. 1, 1909, pp. 1–209.

Bulletin 427 of the United States Geological Survey (Manganese deposits of the United States, by E. C. Harder, 1910) contains brief descriptions of most of the known deposits of the United States, as well as the important deposits of the world, and concise summaries of the chemistry and mineralogy of manganese.

Principal manganese minerals.

Mineral.	Composition.	Percentage of manganese.
Polianite	MnO_2	63.2
Pyrolusite	$MnO_2.n\ H_2O$	60–63
Psilomelane	$MnO_2.(MnKBa)\ O.n\ H_2O$	45–60
Wad	Hydrous impure mixture of manganese oxides	5–50
Manganite	$Mn_2O_3.H_2O$	62.4
Braunite	$3Mn_2O_3.MnO.SiO_2$	69
Franklinite	$(FeZnMn)\ O.(FeMn)_2O_3$	10–19
Rhodochrosite	$MnO.CO_2$	47.56
Rhodonite (manganese pyroxene)	$MnO.SiO_2$	41.9
Tephroite (manganese olivine)	$2MnO.SiO_2$	54.3
Spessartite (manganese garnet)	$3MnO.Al_2O_3.3SiO_2$	33.3

Manganese ores.—Commercial manganese ores are those which contain at least 35 per cent manganese and otherwise conform to the specifications of the trade in which they are used. Deposits of manganese ore [1] occur in many parts of the United States, but are most abundant in the Appalachian and Piedmont regions, in the southern Mississippi Valley, and on the Pacific coast. Small deposits occur in the New England, Rocky Mountain, and Great Basin regions. The principal producing districts up to the present time have been the James River-Staunton River and the Blue Ridge regions in Virginia, the Cave Springs and the Cartersville districts in Georgia, the Batesville district in Arkansas, and the Livermore-Tesla districts in California. Districts of minor importance are the New River region in Virginia, the northeastern Tennessee region, the McCormick region in South Carolina, and the Little Grande district in Utah. Mining and shipping in Virginia is now confined to the Blue Ridge and the James River-Staunton River regions.

Manganiferous iron ores.—Manganiferous iron ores consist of mixtures of manganese and iron oxides and hydrous oxides, which though usually containing manganese in excess of 5 per cent, may contain as little as 1 per cent. The proportion of iron in such ores is highly variable, but usually exceeds 40 per cent. Manganiferous iron ores occur in the United States chiefly in the New England, the Appalachian, and the Lake Superior regions, and minor deposits are found in the southern Mississippi Valley and in the Rocky Mountain region. High-grade manganiferous iron ore used for its manganese content occurs in the Appalachian region. Other manganiferous iron ores, which are so low in manganese that they are classed as iron ores, are produced in the Appalachian and the Lake Superior districts. In the blast furnace they yield a "high-manganese" pig iron, which is used for special purposes.

Manganiferous silver ores.—Manganiferous silver ores consist of mixtures of manganese and iron oxides and hydrous oxides, with small quantities of silver and lead minerals. As a rule the iron content exceeds the manganese content, but locally the iron is altogether absent.

Manganiferous silver ores are divided into three classes, according to their uses.

[1] For greater detail refer to Harder, E. C., Manganese deposits of the United States: Bull. U. S. Geol. Survey No. 427, 1910.

1. The greater part of the manganiferous silver ores mined are used for their silver and lead content. Their content of manganese and iron insures many of these ores a higher price because of their fluxing value.

2. Some manganiferous silver ore is too low in silver and lead to be used as a source of these metals, but is sufficiently high in manganese and iron to be used for the manufacture of ferromanganese and spiegeleisen, a use that is made also of the high-grade manganiferous iron ores already mentioned.

3. A third class of manganiferous silver ore is too low in silver and lead to be used primarily for their content of these metals and too low in iron and manganese to be used for the manufacture of iron-manganese alloys. This ore is sold to the smelters as flux, the iron and manganese becoming waste products, and the silver and lead content being recovered during the smelting.

Manganiferous silver ores occur in the Rocky Mountain and Great Basin regions, the principal producing locality being Leadville, Colo. Leadville ores have been used in making spiegeleisen from time to time, but none are now used for this purpose.

Manganiferous zinc residuum.—Manganiferous zinc residuum is an artificial furnace product consisting of manganese and iron oxides in a matrix of slag. Manganiferous zinc residuum is obtained from zinc volatilizing and oxidizing furnaces using New Jersey zinc ores. The residuum consists largely of iron and manganese oxides, the zinc having been removed by volatilization and collected as zinc oxide. The crude ores contain franklinite, zincite, and willemite and are obtained only from the Franklin Furnace district, New Jersey. Small quantities of zinc residuum are used annually in the manufacture of spiegeleisen.

MANGANESE ORE.

PRODUCTION IN THE UNITED STATES.

The following table shows the quantity, value, and average price per ton of the manganese ore produced in the several States for 1910, 1911, and 1912:

Marketed production of manganese ore in the United States, 1910–1912, by States, in long tons.

State.	1910			1911			1912		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Arkansas	(a)	(a)							
California				(a)	(a)		(a)	(a)	
South Carolina							(a)	(a)	
Virginia	b 2,258	b$22,892	$10.14	c 2,457	c$24,586	$10.01	d 1,664	d$15,723	$9.45
Total	2,258	22,892	10.14	2,457	24,586	10.01	1,664	15,723	9.45

a Included with Virginia.
b Includes production of Arkansas.
c Includes production of California.
d Includes production of California and South Carolina.

Only three States report a production of manganese ore in 1912, and, as heretofore, the output of Virginia exceeded that of all other States combined. South Carolina, which produced no ore since 1907, appears again as a producer.

In spite of the decrease in production in the State, there was greater interest and activity in manganese mining in Virginia in 1912 than for several years. Heretofore the Crimora mine, in Augusta County, has been the principal producer, but during 1912 both the Piedmont Manganese Corporation, operating 6 miles east of Lynchburg, and the Pittsburgh Manganese Co., operating the Kendall and Flick property, near Elkton, besides producing small amounts of ore, have been developing the mines in preparation for steady production. On the Kendall and Flick property the ground is being explored by a new shaft, sunk to a depth of 220 feet, and a thoroughly modern mill has been erected.

The following table shows the total production of manganese ore in the United States, by States, as compiled from previous volumes of Mineral Resources. The figures showing the production prior to 1880 are only approximate; those for the years since 1910 represent the marketed production, based upon reports from the individual producers. Virginia, Georgia, and Arkansas have produced 94 per cent of the total, but for 10 years the production of the latter two States has been negligible.

Production of manganese ore in the United States, 1838–1912, in long tons.

Year.	Alabama.	Arkansas.	California.	Georgia.	Indian Territory, Michigan, Missouri, Montana, and Nevada.	North Carolina.	Pennsylvania, South Carolina, and South Dakota.	Tennessee.	Utah and Vermont.	Virginia.	West Virginia and other States.	Total.
1838–1879		410										410
1866–1879				19,950								19,950
1867–1879			5,500							18,000		23,500
1880				1,800						3,661	300	5,761
1881		100		1,200						3,295	300	4,895
1882		175		1,000						2,982	375	4,532
1883		400								5,355	[a] 400	6,155
1884		800								8,980	[a] 400	10,180
1885		1,483	200	2,580	(Nev.) 200					18,745	50	23,258
1886	75	3,316	100	6,041	(Nev.) 30	14		50		20,567		30,193
1887		5,651		9,024		14				19,835		34,524
1888		4,312	1,500	5,568	(Mich.) 100		(Pa.) 22			17,646	[b] 50	29,198
1889		2,528	53	5,208	(Nev.) 15	47	(S. C.) 124	30	(Vt.) 1,576	14,616		24,197
1890		5,339	386	749	(Nev.) 100	14				12,699		19,287
1891		1,650	705	3,575	(Ind. T.) 206		(S. Dak.) 19		(Vt.) 49	16,248		22,452
1892		6,708		826						6,079		13,613
1893		2,020	400	724				482		4,092		7,718
1894		1,934	278	1,277				922		1,797	(W. Va.) 100	6,308
1895		2,991	525	3,856			(Pa.) 460			1,715		9,547
1896		3,421	284	4,085		2	(Pa.) 265			2,018	(W. Va.) 13	10,088
1897		3,240	484	3,332	(Mich.) 37		(Pa.) 354	11		3,650		11,108
1898	22	2,662	541	6,689				381		5,662		15,957
1899		356	115	3,089	(Mo.) 16	90	(Pa.) 12	19		6,228	(W. Va.) 10	9,935
1900		145	131	3,447	(Mont.) 137			30		7,881		11,771
1901	17	91	610	4,074	(Mo.) 28			400	(Utah) 2,500	4,275		11,995
1902		82	846	3,500			(S. C.) 8			3,041		7,477
1903			16	500			(S. C.) 25		(Utah) 483	1,801		2,825
1904			60						(Utah) 32	3,054		3,146
1905			1	150				20		3,947		4,118
1906		62	1					30	(Utah) 800	6,028		6,921
1907			100				(S. C.) 800	100		4,604		5,604
1908										6,144		6,144
1909			[c]					[c]		[d] 1,544		1,544
1910 *f*		[c]								[e] 2,258		2,258
1911 *f*			[c]							[g] 2,457		2,457
1912 *f*			[c]				(S. C.) [c]			[h] 1,664		1,664
Total	114	49,876	12,836	92,244	869	181	2,089	2,475	5,440	242,568	1,998	410,690

[a] Georgia and North Carolina.
[b] Nevada, North Carolina, South Carolina, Tennessee, and Vermont.
[c] Included with Virginia.
[d] Includes production of California and Tennessee.
[e] Includes production of Arkansas.
f Marketed production.
[g] Includes production of California.
[h] Includes production of California and South Carolina.

The following table shows the quantities of mined manganese ore on hand at the mines at the close of 1911 and 1912:

Stock of manganese ore on hand at the mines December 31, 1911 and 1912, by States, in long tons.

State.	1911	1912
Arkansas	200	200
California	102	105
Virginia	1,405	410
Total	1,707	715

IMPORTS.

The following tables, compiled by the Bureau of Foreign and Domestic Commerce, Department of Commerce, show the imports of manganese ore into the United States from different countries and by ports of entry for 1910, 1911, and 1912:

Imports of manganese ores into the United States, 1910–1912, by countries, in long tons.

Country.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Brazil	53,750	$544,353	41,600	$342,769	81,580	$510,300
Russia	33,120	269,717	19,103	186,590	83,334	490,306
British India	140,965	682,897	106,580	501,746	128,645	644,162
Cuba	2	26				
France	4,853	63,933	4,043	51,648	2,021	25,071
Netherlands	55	935	114	1,992		
Japan	952	14,277				
Germany	4,928	83,369	3,941	76,940	3,245	70,644
United Kingdom	2,330	35,718	600	12,810	752	14,099
Canada	15	704	32	745	55	2,021
Belgium	1,378	15,202	837	11,401	2	26
All other countries			2	150	1,027	12,555
Total	242,348	1,711,131	176,852	1,186,791	300,661	1,769,184

Manganese ores imported into the United States, 1910–1912, by customs districts, in long tons.

Customs district.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Philadelphia, Pa	104,855	$679,974	72,581	$431,455	143,537	$788,243
Baltimore, Md	131,526	930,902	99,008	658,421	153,039	900,273
New York, N. Y	3,548	67,683	3,830	69,260	3,345	65,036
Boston, Mass	1	32	5	259	8	235
New Orleans, La	1,720	16,293			110	670
All other	698	16,247	1,428	27,396	622	14,727
Total	242,348	1,711,131	176,852	1,186,791	300,661	1,769,184

As the United States is practically wholly dependent on foreign ores for its supply it is interesting to note that though this supply has for 10 years come largely from India, Brazil, and Russia, in the order named, the importations from India have been declining since 1906, whereas those from Russia have steadily increased to a maximum in 1912.

The total quantity of manganese ore imported into the United States, as far as has been recorded, is shown in the following table. The figures for the years 1868 to 1888 represent imports from Canada only; those from 1889 to the present time represent total imports.

Imports of manganese ore into the United States, 1868–1912, in long tons.

Year ending—	Quantity.	Year ending—	Quantity.
June 30—		Dec. 31—Continued.	
1868	1,017	1891	28,825
1869	488	1892	58,572
1870	1,402	1893	68,113
1871	1,056	1894	44,655
1872	1,206	1895	86,111
1873	838	1896	31,489
Dec. 31—		1897	119,961
1873	1,031	1898	114,885
1874	782	1899	188,349
1875	203	1900	256,252
1876	412	1901	165,722
1877	891	1902	235,576
1878	626	1903	146,056
1879	1,886	1904	108,519
1880	2,179	1905	257,033
1881	1,704	1906	221,260
1882	894	1907	209,021
1883	1,326	1908	178,203
1884	603	1909	212,765
1885	1,684	1910	242,348
1886	1,818	1911	176,852
1887	1,630	1912	300,661
1888	1,182		
1889 [a]	4,286	Total	[b]3,514,526
1890	34,154		

[a] Figures prior to 1889 represent imports from Canada only, total importations from other countries for these years not being obtainable.

[b] This total duplicates the importation from Jan. 1 to June 30, 1873.

PRODUCTION IN PRINCIPAL PRODUCING COUNTRIES.

The following table gives the latest available statistics with regard to American and foreign production of manganese ore.

Figures for all foreign countries except Canada, Belgium, France, German Empire, Italy, and Russia are taken from Mines and Quarries, London. For these countries (except Russia) the figures are taken from the official statistical reports published by the several Governments. The export figures given for Russia are from a report of Vice Consul Frederic W. Cauldwell, Batum, Russia. The figures for the Philippine Islands are derived from the report of the Bureau of Mines, Manila, P. I.

Production of manganese ore in principal producing countries, 1909–1912, in long tons.

Country.	1909	1910	1911	1912
North America:				
Canada			5	67
Nova Scotia	(a)	22	(b)	(b)
United States	1,544	2,258	2,457	1,664
South America:				
Brazil c	236,982	249,954	(b)	(b)
Europe:				
Austria	17,761	15,447	(b)	(b)
Belgium	6,171			(b)
Bosnia and Herzegovina	5,602	3,937	(b)	(b)
France	9,252	7,874	(b)	(b)
German Empire	75,962	79,291	85,921	(b)
Greece	5,289	40	(b)	(b)
Hungary	11,733	13,061	(b)	(b)
Italy	4,626	4,134	3,460	(b)
Russia	588,456	d 394,405	d 562,690	(b)
Spain	7,703	(b)	(b)	(b)
Sweden	5,189	5,719	(b)	(b)
Turkey	e 7,459	f 12,008	(b)	(b)
United Kingdom	2,768	5,467	4,987	(b)
Asia:				
China	1,500	(b)	(b)	(b)
India	642,675	800,907	(b)	(b)
Japan	8,708	11,121	(b)	(b)
Philippine Islands	(g)			
Portuguese India	(h)	(h)	(b)	(b)
Africa:				
Cape Colony		(i)	(b)	(b)
Natal		51	(b)	(b)
Oceania:				
Australia	603	815	(b)	(b)
New Zealand	6	5	(b)	(b)

a Not stated.
b Statistics not yet available.
c Exports.
d Exported from Batum and Poti.
e Year ending Mar., 1909.
f Exported from Stratoni.
g Quantity not stated; value of production $6,250.
h Quantity not stated. Exports valued at $13,607 in 1909 and at $18,609 in 1910.
i Quantity not stated. Exports valued at $7,786.

MANGANIFEROUS ORES.

Manganiferous ores are of two classes: (1) Those which contain iron greatly in excess of manganese and which are smelted direct to a manganiferous cast iron containing 1 to 4 per cent manganese, or those in which manganese equals or is in excess of the iron and which with other iron ores is smelted to a similar product; and (2) those which are used for fluxing, the manganese oxides forming a more fluid slag. Of the first class are ores of the Lake Superior region, Arkansas, and Virginia. So far as can be ascertained the manganiferous ores of Colorado are the only ores used for fluxing, and the smaller demand for these ores is due to the fact that the smelting of iron ores is of minor importance compared to the smelting of lead and copper ores containing gold and silver, in which industry refractory mixtures frequently require the use of manganiferous iron ores to aid in fluxing. Up to 1909 a part of the Colorado ores was used in the manufacture of spiegeleisen.

For use as a flux the value of manganiferous iron ore, like that of many ores which contain both precious and base metals, depends on several factors, among the more important of which are: (1) Their combined manganese and iron content, (2) their content of silica, (3) their content of precious metals, (4) the deductions and adjustments of

these factors, based on the temporary demands of the smelter that buys such ores. The ores produced in the Leadville district, Colorado, for 1912, range in composition as follows: Manganese, trace to 24 per cent; iron, 8 to 50 per cent; siliceous material (insoluble), 5 to 15 per cent; silver, trace to 10 ounces per ton; gold, trace; lead, trace to 5 per cent. The average composition of the entire product is manganese, 15 per cent; iron, 33 per cent; siliceous material, about 10 per cent; silver, 4.9 ounces; gold, trace; lead, trace.

For such ores smelters pay at the rate of 15 cents per unit (or per cent) for the excess over 40 per cent of the combined iron and manganese content after deducting the silica or siliceous material, and for silver 95 per cent of the content at New York quotations. The deduction of 40 per cent from the combined iron-manganese content is made in lieu of a charge for smelting. By this method of calculating, the value of the Leadville ores, exclusive of that of the precious metal, ranges from nothing to $1.80 per ton, and the average value of the total production is 23 cents per ton. If the value of the silver content be added to this, the total is $3.21 per ton.

Heretofore, it has been possible to state only the total value of these ores, as but a single figure, the gross value, has been reported by producers. More complete data are now available and the present method of calculation is more closely in accord with that adopted by the Geological Survey.

The production of Lake Superior manganiferous ores for 1912 was approximately twice that of the previous year and within a few thousand tons of the maximum previous annual output. The output of these ores also appears in the figures showing the production of iron ore. The production in Arkansas was the lowest for 8 years and that in Virginia was the greatest in 10 years.

The following table shows the production of Arkansas and Colorado for 1909, 1910, 1911, and 1912, and the average price per ton:

Production of manganiferous ores used principally for fluxing or other purposes in Colorado and Arkansas, 1909–1912, in long tons.

Year.	State.	Percentage of manganese.	Quantity.	Value.	Average price per ton.
1909	Arkansas	28	3,325	$5,819	$1.75
	Colorado		52,119	179,813	3.45
1910[a]	Arkansas	20–25	5,030	9,700	1.93
	Colorado	5–26	55,770	176,448	3.16
1911[a]	Arkansas	20	2,177	4,354	2.00
	Colorado	4–40	41,753	109,340	2.62
1912[a]	Arkansas	20	1,332	2,997	2.25
	Colorado	6–24	48,618	12,646	.23
Total			210,124	501,117	2.38

[a] Marketed production.

The production of manganiferous ores in the United States from 1885 to 1912 is shown in the table on the next page.

Production of manganiferous ores in the United States, 1885–1912, in long tons.

Year.	Arkansas.	Colorado.[a]	Colorado.[b]	Lake Superior region.	Virginia.	Other States.	Total.
1885						(Mont.)[b] 4,263	4,263
1886			[c] 60,000	257,000			317,000
1887			[c] 60,000	210,000	1,025	[d] 726	271,751
1888			[c] 60,000	201,036		[e] 1,096	262,132
1889			64,987	81,359			146,346
1890		6,397	51,840	61,863			120,100
1891		964	79,511	132,511			212,986
1892		2,942	62,309	147,431	3,000		215,682
1893	160	5,766	55,962	110,648	1,188	(N. C.) 20	173,744
1894		7,022	31,687	198,466			237,175
1895		13,464	54,163	112,265			179,892
1896		9,072	138,079	329,640			476,791
1897		16,519	149,502	184,585		(Vt.) 1,200	351,806
1898		18,848	99,651	268,862		(Pa.) 100	387,461
1899		29,355	79,855	732,490			841,700
1900		43,303	188,509	334,274			566,086
1901		62,385	228,187	512,084		(N. C.) 20	802,676
1902		13,275	194,132	884,939	3,000		1,095,346
1903		14,856	179,205	566,835	2,802		763,698
1904	600	17,074	105,278	365,572			488,524
1905	3,321	45,837	81,738	720,098			850,994
1906	8,900	32,400	[f]	[g] 1,000,000			1,041,300
1907	4,133	67,514	32,197	314,316		(N. M.) 7,000	425,160
1908	4,066	15,973	35,581	467,140	274		523,034
1909	3,325	12,905	52,119	775,035	305		843,689
1910	5,030		55,770	558,634	301		619,735
1911	2,177		41,753	477,920	507		522,357
1912	1,332		48,618	816,984	1,567		868,501
Total	33,044	435,871	2,290,633	10,821,987	13,969	14,425	13,609,929

[a] Manganiferous silver ore used in the manufacture of spiegeleisen and ferromanganese.
[b] Manganiferous silver ore used for flux; mainly from Colorado, but in a few cases probably including other Western States.
[c] Contains some Montana ore.
[d] Georgia 195 tons, Maine 50 tons, and Vermont 481 tons.
[e] North Carolina, South Carolina, and Tennessee 96 tons, and Vermont 1,000 tons.
[f] Not recorded.
[g] Estimated.

MANGANIFEROUS ZINC RESIDUUM.

Unique deposits of zinc ore containing franklinite, willemite, zincite, calcite, and minor silicate and other minerals, occur near Franklin Furnace, N. J. By mechanical and electromagnetic processes of separation, three products are obtained from these ores, one containing the greater proportion of the franklinite and the remaining two the other zinc minerals. The franklinite product is first roasted with anthracite to eliminate the zinc, which is recovered as zinc oxide, and the residue, containing 12 per cent manganese and 40 per cent iron, is smelted to spiegeleisen.

In 1912 the production of manganiferous residuum was less than that for 1911, though the value was greater. The production, value, and price per ton from 1908 to 1912 are given in the following table:

Production of manganiferous zinc residuum in the United States, 1905–1912, in long tons.

Year.	Quantity.	Value.	Average price per ton.
1905	90,289	$90,289	$1.00
1906	93,461	93,461	1.00
1907	93,413	280,239	3.00
1908	110,225	330,675	3.00
1909	141,264	423,792	3.00
1910	137,173	411,519	3.00
1911	109,296	291,344	2.67
1912	104,670	314,010	3.00
Total	879,791	2,235,329	2.54

The following table shows the production of manganiferous zinc residuum from 1889 to 1912:

Production of manganiferous residuum from zinc roasting in the United States, 1889–1912, in long tons.[1]

1889	43,648	1902	65,246
1890	48,560	1903	73,264
1891	38,228	1904	68,189
1892	31,859	1905	90,289
1893	37,512	1906	93,461
1894	26,981	1907	93,413
1895	43,249	1908	110,225
1896	44,935	1909	141,264
1897	33,924	1910	137,173
1898	48,502	1911	109,296
1899	65,010	1912	104,670
1900	87,110		
1901	52,311	Total	1,688,319

FERROMANGANESE AND SPIEGELEISEN.

PRODUCTION.

In 1912 the marketed production of ferromanganese and spiegeleisen in the United States was 227,939 tons, the greatest since 1907, and 49,324 tons greater than in 1911. Both spiegeleisen and ferromanganese were produced in Pennsylvania and Illinois during the year.

Production of spiegeleisen and ferromanganese in the United States, 1872–1912, in long tons.

1872	4,072	1894	120,180
1873	3,930	1895	171,724
1874	4,070	1896	131,940
1875	6,993	1897	173,695
1876	5,907	1898	213,769
1877	7,897	1899	219,768
1878	9,530	1900	255,977
1879	12,438	1901	291,461
1880	17,503	1902	212,934
1881	18,827	1903	192,661
1882	19,610	1904	219,446
1883	21,941	1905	289,983
1884	30,262	1906	300,500
1885	30,956	1907	339,348
1886	42,841	1908	152,018
1887	42,498	1909	225,040
1888	48,901	1910	226,216
1889	76,628	1911[2]	178,615
1890	133,180	1912[2]	227,939
1891	127,766		
1892	179,131	Total	5,069,213
1893	81,118		

[1] The manufacture of spiegeleisen from manganiferous residuum was begun in 1870, but there is no record of the tonnage of raw material used prior to 1889.

[2] Marketed production. Figures collected by United States Geological Survey.

The content of manganese in spiegeleisen and ferromanganese varies slightly according to the source of the ores, and the method of manufacture and the prices of the alloys depend on the percentage of manganese.

The following table shows the range in prices for the iron-manganese alloys for 1912:

Prices per long ton for iron-manganese alloys during 1912.

Alloy.	Percentage of manganese and silicon.	January.	Maximum.	Minimum.	December.
Ferromanganese [a]	75–80 Mn	41.95	76.95	41.95	69.95
Spiegeleisen [a]	15–20 Mn	21.50	26.90	21.50	26.90
Silicospiegel [a]	15–20 Mn, 10–12 Si	23.40	26.90	22.40	26.90

[a] Compiled from weekly reports published in the Industrial World of Pittsburgh.

IMPORTS.

The imports of ferromanganese for 1912 exceeded those of any previous year except one, and the imports of spiegeleisen were the lowest in 10 years, dropping to the practically negligible figure of 1,015 tons. The increases in domestic production and in imports are an index of the prosperous conditions of the steel industry.

According to a recent decision of the Board of General Appraisers [1] an alloy containing manganese, 93.92 (96.80); iron, 2.33 (1.40); silicon, 1.56 (1.40); carbon, 0.10 (0.40) per cent [2] was dutiable as "metals unwrought" at 20 per cent ad valorem and not at $2.50 per ton, the duty on ferromanganese.

The following table, compiled from data furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce, shows the quantity and value of the imports of ferromanganese and spiegeleisen from 1903 to 1912:

Ferromanganese and spiegeleisen imported and entered for consumption, 1903–1912, in long tons.

Year.	Ferromanganese.		Spiegeleisen.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	41,519	$1,699,666	122,015	$2,709,317	163,534	$4,408,983
1904	21,813	707,037	4,623	132,461	26,436	839,498
1905	52,841	1,884,651	55,457	1,336,104	108,298	3,220,755
1906	84,359	4,953,644	103,268	2,942,940	187,627	7,896,584
1907	87,400	5,354,656	48,994	1,399,381	136,394	6,754,037
1908	44,624	1,860,664	4,579	125,054	49,203	1,985,718
1909	88,934	3,396,381	16,921	356,447	105,855	3,752,828
1910	114,228	4,341,071	25,383	489,049	139,611	4,830,120
1911	80,263	3,015,062	20,970	405,444	101,233	3,420,506
1912	99,137	3,906,920	1,015	28,094	100,152	3,935,014

[1] Eng. and Min. Jour., vol. 93, 1912, p. 829.
[2] Figures in parentheses are those of importer's analyst.

USES.

The following table shows the composition and uses of some manganese metals and minerals:

Manganese metals and minerals.[1]

1. Alloys:
   - Ferromanganese (alloy of manganese and iron).
   - Spiegeleisen (alloy of manganese and iron).
   - Manganese steel (alloy of manganese and iron).
   - Siliconspiegel (alloy of manganese, iron, and silicon).
   - Manganese bronze (alloy of manganese and copper).
   - Silver bronze (alloy of manganese, aluminum, zinc, and copper).
   - Alloys of manganese with aluminum, zinc, and tin.
2. Oxidizers:
   - Decolorizer of glass.
   - Dry batteries.
   - Leclanche's cell.
   - Drier of varnishes and paints.
   - Preparation of oxygen on a small scale.
   - Manufacture of disinfectants (manganates and permanganates).
3. Coloring materials:
   - Coloring glass, pottery, tiles, and bricks.
   - Calico printing and dyeing.
   - Paints (green; violet).
4. Flux in smelting silver and lead ores.
5. Gems or ornamental stones, in the form of the minerals rhodonite and spessartite.
6. Fertilizer.
7. Various lesser chemical, manufacturing, and medical uses.

1. *Alloys.*—Three classes of ores—manganese ores, manganiferous iron ores, and manganiferous zinc residuum—are used directly or indirectly in the manufacture of iron and steel. Ores used in the manufacture of iron-manganese alloys should contain at least 40 per cent manganese and less than 0.20 per cent phosphorus. Silica and other impurities are easily eliminated in the operation of smelting, but most of the phosphorus in the ores remains and is present in the final product. For making nonferrous manganese alloys high-grade ores relatively low in iron are desired. Manganiferous iron ores are not now used in the manufacture of iron alloys of manganese, such as are used in the steel industry, but are used for the direct production of manganiferous cast iron, which is used for making various kinds of castings. It possesses some of the properties of manganese steel, notably resistance to abrasion.

Though manganese in the form of ferromanganese is added to practically all steel, whether produced by the Bessemer or open-hearth process, the amount present in the final product is not so large as to greatly affect its physical properties, at least not to the same extent as the carbon content. Manganese steel contains from 12 to 40 per cent manganese, and these proportions are essential to produce the peculiar properties possessed by these steels, which are hard but, with proper heat treatment, not brittle, and malleable, though they offer great resistance to cutting tools. These properties make the manganese steels highly useful in the manufacture of two classes of articles: (1) Those which must offer great resistance to abrasion, either by friction against smooth, hard surfaces, or against hard, brittle and

[1] Adapted from table given by L. Leigh Fermor (Manganese deposits of India: Memoirs of the Geol. Survey of India, vol. 31, Part III, p. 581, 1909), which in turn was adapted from table presented by R. A. F. Penrose, Ann. Rept. Arkansas Geol. Survey, vol. 1, 1890, p. 7.

angular materials; (2) those which must resist strains due to shock accompanying such abrasion. Articles now commonly made of manganese steel are: Gears, pinions, sprockets, chains, dies, liners, wearing plates, rolls and rollers, railroad frogs and switches, and the crushing faces and digging parts of crushing and pulverizing machinery, such as plates, dies, rollers, stamp-mill shoes. For making some of these articles, manganese steel is practically the only alloy available, but for making others it is no more desirable than some other alloys, such as those of chromium, vanadium, and tungsten, with which it must compete at current prices.[1]

The nonferrous alloys of manganese have as yet small use and the amount of manganese ores necessary to supply them is not important.

2. *Oxidizers.*—Manganese used as an oxidizer acts only as an agent for carrying oxygen, hence it is important that the ores employed for the purpose contain a large percentage of manganese dioxide, either in the form of the minerals pyrolusite (or polianite, which is rare), or other minerals that easily liberate oxygen.

The following table shows the proportion of manganese dioxide and available oxygen contained in the common manganese minerals:[2]

Manganese oxide and available oxygen in certain manganese minerals.

Mineral.	Manganese dioxide.	Available oxygen.
Pyrolusite (polianite)	100.00	18.39
Psilomelane	42.46–77.33	7.81–13.06
Manganite	49.44	9.09
Braunite	43.11	7.93
Hausmannite	37.99	6.99
Rhodochrosite	None.	None.

Among the industries using manganese ores as an oxidizer or source of oxygen, the manufacture of flint glass consumes the largest quantity. Practically all the ores used for this purpose are imported, the principal sources being the deposits in the southern Caucasus Mountains, Russia, and Thuringia, Germany. These ores usually contain at least 80 per cent manganese dioxide, and less than 1 per cent iron. The amount of ore consumed annually by the individual glass plants is small, ranging from 10 to 200 tons each, and for this reason the ore is purchased from importers, who guarantee the grade. From 5 to 12 pounds of manganese ore per ton of sand (equivalent to 2 to 5 pounds per ton of glass) is used, according to the amount of iron present. The present total annual consumption of manganese ores for their oxygen content in the United States is estimated at 10,000 tons.

For making dry batteries high-grade pyrolusite containing at least 85 per cent manganese dioxide and less than 1 per cent iron is used. The source of supply for the United States is largely the deposits of the Caucasus Mountains, Russia.[3]

3. *Coloring materials.*—The manganese ores that are commonly used in coloring pottery, tiles, and bricks are the argillaceous varieties, which contain less than 40 per cent manganese and more siliceous

[1] An article by S. R. Stone, entitled "Manganese steel for machinery parts," stating in detail the uses to which manganese steel is applicable, was published in Iron Age, vol. 91, 1913, p. 141.

[2] Fermor, L. L., loc. cit.

[3] Richardson, H. K., The modern dry cell: Met. and Chem. Industry, vol. 10, p. 531, 1912.

material than is permitted in ores used in the manufacture of alloys. The quantity of manganese ores used in printing and dyeing and in the manufacture of paint pigment is small.

4. *Fluxes in smelting silver and lead ores.*—The manganese ores used as fluxes in smelting silver and lead ores are necessarily those which are relatively impure or which contain metals of greater value than the manganese. The ores are either too impure or the deposits are too far from steel works to be used in making ferroalloys.

5. *Gems and ornamental stones.*—Rhodonite is a pink to rose-red mineral of hardness 6 (Mohs scale of hardness), which in places occurs in masses sufficiently large to permit its use as an ornamental stone. There is no present great demand for stone of this color in the United States, but should a demand arise it can be supplied from large masses in Maine, Massachusetts, Vermont, New Hampshire, Rhode Island, and Connecticut.[1]

6. *Fertilizer.*[2]—Many experiments have been made with manganese compounds as fertilizers in water culture, pot culture, and in the field. The salts of manganese used have been the dioxide, carbonate, iodide, nitrate, chloride, and sulphate, in quantities ranging from 9 to 5,340 pounds, but usually less than 100 pounds to the acre, especially of the more soluble salts. The results of the experiments have varied somewhat, but most applications of not over 50 pounds of manganese salts to the acre have given increased yields of a variety of crops on widely different soils. The crops fertilized have been rice, peas, beans, vetch, oats, wheat, barley, corn, potatoes, sugar beets, carrots, mustard, cabbage, onions, radishes, apricots, tobacco, and grass. The action seems to be more favorable on rice and the leguminous crops than on corn, carrots, sugar beets, barley, potatoes, and tobacco. In many of the experiments the increase in yield has been very appreciable—more than 25 per cent—but some experiments produced no increase. Large applications of manganese salts—that is, more than 75 or 100 pounds to the acre—have in general proved injurious.

Other uses.—A review of the manganese-ore industry during recent years shows that though now, as heretofore, the greater part of the ores is consumed by the iron and steel industries, changes have been made in disposing of the remaining portion. Until recently most of the chlorine used in numerous chemical trades was made by the action of sulphuric acid on a mixture of manganese dioxide and salt, by which action 1½ pounds of dioxide were needed to produce 1 pound of chlorine. This process, however, has been displaced by that of producing chlorine by the electrical decomposition of salt (sodium chloride), either fused or in water solution, and as the chief object of the process is to produce sodium hydrate or other sodium salts, chlorine is a by-product, and more is produced than the trades can now consume.

The same may be said of the manufacture of oxygen. Much oxygen has heretofore been produced both for commercial and for experimental purposes by heating a mixture of manganese dioxide and potassium chlorate. Though this method is possibly still used in small laboratories, most commercial establishments now use

[1] Kunz, G F., Gems and precious stones of North America, Scientific Publishing Co., 1890, pp. 151–152.
[2] Abstracted from M. X. Sullivan and W. O. Robinson, Manganese as a fertilizer: Circ. Bur. Soils No. 75, U. S. Dept. Agr., January, 1913.

oxygen prepared by the fractional distillation of liquid air or by the electrolysis of water. It is highly probable, however, that these losses in the uses of manganese ores have been more than compensated by the increased demand for it for use in dry batteries.

VALUE OF ORES.

The value of ores containing manganese depends on their mineralogical nature as well as their purity. The prices paid for ores of medium grade, for which the demand is greatest, are relatively stable, but the value of high-grade ores, which are consumed in much smaller quantities, fluctuates greatly.

The value of the ores used in the metallurgical industries varies with their content of metallic manganese and is governed largely by the specifications announced from time to time by the Carnegie Steel Co., Pittsburgh, Pa. The specifications now used are given below:

Schedule of prices paid per ton of 2,240 pounds for domestic manganese ore delivered at Pittsburgh or Bessemer, Pa., and South Chicago, Ill.

Prices are based on ores containing not more than 8 per cent silica or 0.20 per cent phosphorus and are subject to deductions as follows: For each 1 per cent in excess of 8 per cent silica there shall be deduction of 15 cents per ton; fractions in proportion.

For each 0.02 per cent, or fraction thereof, in excess of 0.20 per cent phosphorus there shall be a deduction of 2 cents per unit of manganese per ton.

Ores containing less than 40 per cent manganese or more than 12 per cent silica or 0.225 per cent phosphorus are subject to acceptance or refusal at the buyer's option.

Settlements are based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken being deducted from the weight.

Percentage of metallic manganese in ore.	Price per unit in cents—manganese.
Over 49	25
46 to 49	24
43 to 46	23
40 to 43	22

According to these specifications, the prices paid for the ores range from $7 to $12.50 a ton.

The value of an ore adapted to use as an oxidizer varies with its content of manganese dioxide, and, in contradistinction to those used in metallurgical industries, does not depend, except incidentally, on its content of manganese metal. It is usually specified that ore required for use as an oxidizer shall contain at least 80 per cent manganese dioxide and not more than 1 per cent iron. As far as can be ascertained, there appears to be no established schedule, such as exists in the steel industry, but brokers supply ore under guaranteed specifications in lots ranging from 5 to 100 tons. Prices usually range from $20 to $35 per ton, but some small lots which are exceptionally well adapted to special uses have been disposed of at $50 a ton.

As the manganese content of manganiferous iron ores and manganiferous silver ores is used only indirectly, the value of these ores depends on local conditions in the metallurgical industries which consume them.

These ores are of value principally for their content of iron, silver, or metals other than manganese, which only rarely adds more than

$3 a ton to their value. The more impure ores, such as will serve for coloring glass and pottery, are sold at prices ranging from $2 to $6 a ton, f. o. b. works. Producers supply the greater part of these ores directly to the trades, and prices are wholly subject to contract.

Manganiferous zinc residuum is not sold in the open market but is smelted to spiegeleisen by the companies that produce it.

NOTES ON DOMESTIC MANGANESE DEPOSITS.

Other than the exploitation of old deposits, with the view to increased production, there were no important developments in the manganese ore industry in the Eastern States during 1912. Manganese ore is reported [1] to have been found in a clay deposit operated by the Rapid City Brick & Tile Co., near Treswell, Tenn., but the extent of the occurrence is not known.

Deposits of manganese ore in eastern Oklahoma were examined by the writer in March, 1912. They are in northeast McCurtain County, in Tps. 2, 3, and 4, S., Rs. 24 and 25 E., near Hochatown, on Mountain Fork River. Though known locally for a number of years, they have never been explored, for they occur in an isolated and undeveloped region.

Two classes of deposits have been found in the region—first, and more important, deposits in which psilomelane cements and locally more or less replaces fractured chert and sandstone of Ordovician age; second, deposits in which wad (impure hydrous oxide of manganese) occurs as small round nodules in stream alluvium. The deposits of the second class are confined to superficial material and are not important. Six deposits of the first class were examined. The deposits consist of a number of pockets of highly irregular shape and variable size, lying in belts that range in width from 12 to 35 feet and in length from 200 to 900 feet. Though many pockets contain lumps of solid ore weighing as much as several hundred pounds, the minable portions of the deposits would only locally yield material containing more than 15 per cent manganese minerals. In order to prepare a marketable product the ore would have to be crushed and concentrated in jigs or tables. The deposits are essentially similar in superficial aspect—that is, in extent and grade of material—to those which occur in Polk, Montgomery, Pike, and Garland counties, Ark. and which have been described by Penrose.[2]

Without greatly improved transportation facilities and a better market than exists at present, the deposits can hardly be operated with profit.

In the Lake Superior region a new deposit of manganiferous iron ore is reported to have been found in Crow Wing County, Minn.[3] Samples from drill cores which have been analyzed contain 16 to 34 per cent manganese and 28 to 38 per cent iron.

In the Rocky Mountain region several deposits of manganese ore have been recently noted by geologists of the United States Geological Survey. R. W. Richards reports a pocket of manganese ore 4 feet in diameter in gravels of Wasatch age, 1½ miles southwest of Bloomington, Idaho; also nodules of manganite and pyrolusite between beds

[1] Personal communication to the writer.
[2] Penrose, R. A. F., Manganese: Arkansas Geol. Survey, vol. 1, 1891, pp. 340–371.
[3] Personal communication to the writer.

of limestone (Ellis ? formation—Jurassic) and shale 4 miles northwest of Melrose, Mont. These deposits will be described in forthcoming publications of the Geological Survey. The extent of the deposits is not known. W. T. Lee reports the discovery of prospect pits which show nodules of manganese minerals filling fractures and solution cavities in Ordovician quartzite on the west slope of the Caballo Mountains, 8 miles north of Shandon, N. Mex.

NOTES ON FOREIGN MANGANESE DEPOSITS.

RUSSIA.[1]

During the year 1912 manganese was produced in three parts of Russia, the Caucasus (Chiaturi), South Russia (Nikopol), and the Urals. The manganese ores of the Ural region, because of their isolated situation, are not exported, but are used in metallurgical works in the Urals. Of the other two districts, 90 per cent of the production of the Caucasus is exported and 10 per cent is used in the South Russian iron works, whereas only 20 per cent of the ores of the Nikopol district is exported and 80 per cent is sent to neighboring iron works. The most notable feature of the Russian manganese industry in 1912 was the increase in shipments to the United States. Up to 1899 England was the principal importer of Chiaturi manganese ores, but now does not take over 10 per cent. Recently the greater portion of the ore shipped from this district has gone to Germany and during 1912 almost half of the Caucasus manganese ore was imported to that country by way of the ports of Holland.

The total production of the Ural region is not large, the average annual production from 1899 to 1908 being 4,190 tons, 0.7 per cent of the total of the Empire. The year 1912 was a record one for Russian manganese mining, the production amounting to about 1,000,000 tons.

SPAIN.

The manganese deposits of the Province of Huelva[2] are situated in the southwestern portion of Spain, on the south slope of the Sierra Morena. The deposits, of which about a hundred are known, are lenticular masses of manganese and other minerals, which are essentially parallel to the bedding planes of a group of folded and metamorphosed phyllites, graywacke, and hornstone of Paleozoic age. Rhodochrosite (manganese carbonate) and rhodonite (manganese silicate) constitute the greater proportion of the masses but pyrite, garnet, and mica are present. A number of lenticular masses of igneous rocks, notably diabase and quartz porphyry, are associated with the deposits.

Many of the deposits are as much as 500 feet long and 100 feet broad and the largest is 3,300 feet long and 330 feet broad. The manganese minerals are oxidized to pyrolusite and psilomelane to an

[1] Abstracted from De Hautpick, E., Russia in 1912: Min. Jour., vol. 100, p. 6, 1913.
[2] Translated and abstracted from Hoyer, Contribution to the knowledge of the manganese deposits of the Province of Huelva: Zeitschr. prakt. Geologie, vol. 19, 1911, pp. 407–438.

average depth of 65 feet but locally this oxidation extends to 250 feet. Prior to 1893 the production was confined to the superficial oxide ores, but recently carbonate and silicate ores have been shipped. Carbonate ores contain 28 to 45 per cent manganese, 3 to 7 per cent iron, and 5 to 15 per cent silica, whereas silicate ores contain 39 to 45 per cent manganese and 20 to 22 per cent silica. In most of the ores the phosphorus content is less than 0.10 per cent.

Since 1906 the deposits have yielded about 125,000 tons of carbonate ores.

PRECIOUS AND RELATED SEMIPRECIOUS METALS IN 1912.

(General and Mines Reports.)

PREFATORY NOTE.

By H. D. McCaskey.

In the following pages will be found the general and mines reports on gold, silver, copper, lead, and zinc in 1912. The complete report of the United States Geological Survey on the precious and related semiprecious metals—gold, silver, copper, lead, and zinc—is divided, to facilitate advance publication, into sixteen sections, the first four giving figures of output for the calendar year in marketable form for the metals named as obtained from the smelters, refineries, and mints, and general reviews of the respective industries for the five metals for the entire country, and the last twelve giving the production as obtained from the mines, so far as possible, in terms of recoverable metals in ores sold or treated during the calendar year, and supplying information in detail relative to the mining industry by States, counties, and mining districts. The figures given in the general reports are the final official statistics of production for the country and the States for 1912. Further characteristics and differences are fully explained in the individual reports.

The sixteen sections are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Precious and semiprecious metals in the Eastern States (mines report).
Precious and semiprecious metals in the Central States (mines report).
Precious and semiprecious metals in Alaska (mines report).
Precious and semiprecious metals in Arizona (mines report).
Precious and semiprecious metals in California and Oregon (mines report).
Precious and semiprecious metals in Colorado (mines report).
Precious and semiprecious metals in Idaho and Washington (mines report).
Precious and semiprecious metals in Montana (mines report).
Precious and semiprecious metals in Nevada (mines report).
Precious and semiprecious metals in New Mexico and Texas (mines report).
Precious and semiprecious metals in South Dakota and Wyoming (mines report).
Precious and semiprecious metals in Utah (mines report).

In measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price per unit of metal production (gold excepted, which is fixed by law at $20.671834625323 per fine

ounce) is based upon the averages for the years 1912 and 1911 of daily market prices of metals as follows:

Metal.	1912	1911
Silver, New York price.....per fine ounce (troy)..	$0.615	$0.53
Copper, New York price.....per pound..	.165	.125
Lead, New York price.....do....	.045	.045
Zinc (spelter), St. Louis price.....do....	.069	.057

It is to be understood, of course, that the full market values are not received for metals in ore and intermediate products, but only for metals in marketable form, and that average daily quotations do not necessarily agree with average prices received.

Each of the sixteen sections is published in a separate pamphlet and can be obtained on request made to the Director, United States Geological Survey, Washington, D. C.

GOLD AND SILVER.

By H. D. McCaskey.[a]

ACKNOWLEDGMENTS.

To the thousands of men engaged in the mining and metallurgical industries, to merchants, bankers, and transportation officials of the United States and Alaska, to the Bureau of the Mint, the Post Office Department, the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and to other officials, public and private, who have cooperated with the United States Geological Survey in furnishing information on the production of gold and silver, acknowledgment is most gratefully made. This cooperation is each year more freely given, and the results are correspondingly of increased value, not only to those directly concerned, but also to the public at large. To the authors of the various Survey mine reports on the production of gold, silver, copper, lead, and zinc, in the Central and Western States, and in Alaska, Messrs. B. S. Butler, A. H. Brooks, J. P. Dunlop, C. N. Gerry, V. C. Heikes, Charles W. Henderson, and Charles G. Yale, the writer is especially indebted.

PRODUCTION OF GOLD AND SILVER IN 1912.

GENERAL STATEMENT.

The production of gold and silver in the United States from domestic ores in 1912 is shown in the following table in distribution by States:

Approximate distribution by producing States and Territories of the production of gold and silver in the United States for the calendar year 1912, in fine ounces.[b]

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	795	$16,400	200	$100
Alaska	831,981	17,198,600	539,700	331,800
Arizona	183,117	3,785,400	3,445,500	2,118,000
California	967,887	20,008,000	1,384,800	851,200
Colorado	906,606	18,741,200	7,933,100	4,876,500
Georgia	526	10,900	200	100

[a] Valuable aid has been rendered by J. P. Dunlop in the preparation of the tables of this report and in the verification of all the figures.

[b] Gold value, $20.671834625323 per fine ounce. Average commercial price of silver in 1912, 61.5 cents per fine ounce.

Approximate distribution by producing States and Territories of the production of gold and silver in the United States for the calendar year 1912, in fine ounces.

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Idaho	67,810	$1,401,700	7,862,900	$4,833,400
Illinois			1,800	1,100
Maryland and Pennsylvania	60	1,200	700	400
Michigan			543,500	334,100
Missouri			30,000	18,400
Montana	179,371	3,707,900	12,524,000	7,698,500
Nevada	656,722	13,575,700	13,851,400	8,514,400
New Mexico	36,506	754,600	1,460,800	898,000
North Carolina	7,544	156,000	2,300	1,400
Oregon	36,749	759,700	54,000	33,200
Philippine Islands	22,331	461,600	5,800	3,600
South Carolina	744	15,400		
South Dakota	378,470	7,823,700	205,800	126,500
Tennessee	557	11,500	112,000	68,800
Texas	105	2,200	379,800	233,500
Utah	208,623	4,312,600	13,076,700	8,038,300
Virginia	14	300	700	400
Washington	33,023	682,600	350,800	215,600
Wyoming	1,176	24,300	300	200
Total	4,520,717	93,451,500	63,766,800	39,197,500

The figures in this table are also those of the Director of the Mint. They result from cooperation of the Bureau of the Mint and the United States Geological Survey and are agreed upon after conference and adjustment between the two bureaus. They are, therefore, final for both.

The totals of this table are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by information collected by the United States Geological Survey direct from the producing mines and tabulated for the mine reports later discussed. The data giving the total production, and in part the distribution, are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ores, matte, etc., exported for reduction. The last item is of small relative importance.

Gains and losses in the production of gold and silver in the several States and Territories, as compared with the output of 1911, are shown in the following table:

Increase (+) or decrease (−) in production of gold and silver in the United States in 1912, by States and Territories, in fine ounces.

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	− 95	− $2,000		
Alaska	+ 25,802	+ 533,400	+ 71,400	+ $78,900
Arizona	+ 12,769	+ 264,000	+ 216,600	+ 374,400
California	+ 3,846	+ 79,500	+ 113,900	+ 164,900
Colorado	− 19,233	− 397,600	+ 601,900	+ 917,700
Georgia	− 1,022	− 21,100	− 400	− 200
Idaho	+ 2,122	+ 43,800	− 322,000	+ 413,600
Illinois			− 2,200	− 1,100
Maryland and Pennsylvania	+ 55	+ 1,100	+ 600	+ 300
Michigan			+ 35,800	+ 60,000
Missouri			− 19,100	− 8,100
Montana	+ 2,817	+ 58,200	+ 360,100	+1,130,000
Nevada	−218,716	−4,521,200	+ 665,500	+1,394,000
New Mexico	− 341	− 7,100	+ 119,400	+ 173,700
North Carolina	+ 4,066	+ 84,100	+ 1,300	+ 900
Oregon	+ 6,070	+ 125,500	+ 9,200	+ 9,000
Philippine Islands	+ 12,883	+ 266,300	+ 2,700	+ 1,900
Porto Rico	− 97	− 2,000	− 100	− 100
South Carolina	− 228	− 4,700		
South Dakota	+ 19,068	+ 394,200	+ 5,500	+ 18,300
Tennessee	− 19	− 400	+ 5,000	+ 11,000
Texas	− 84	− 1,700	− 64,400	− 6,400
Utah	− 8,397	− 173,600	+1,446,100	+1,757,800
Virginia	− 136	− 2,800	+ 500	+ 300
Washington	− 7,612	− 157,400	+ 120,500	+ 91,200
Wyoming	+ 146	+ 3,000	− 400	− 200
Total net increase (+) or decrease (−)	−166,336	−3,438,500	+3,367,400	+6,581,800

In addition to the production of gold and silver from domestic sources in 1912, the smelters and refineries produced as refined bullion from foreign ore, matte, and unrefined bullion 965,759 fine ounces of gold and 66,650,109 fine ounces of silver. Of the foreign gold, 340,672 fine ounces is credited to Mexico, 434,829 ounces to Canada (including British Columbia, the Yukon, and the Klondike), 96,005 ounces to Central America and South America, 7,803 ounces to the Philippines, 773 ounces to Cuba, and 85,677 ounces to all other foreign sources. Of the foreign silver 41,804,441 fine ounces are credited to Mexico, 13,118,334 ounces to Canada (including British Columbia, the Yukon, and the Klondike), 10,167,401 ounces to Central America and South America, 2,651 ounces to the Philippines, 12,831 ounces to Cuba, and 1,544,451 ounces to all other foreign sources.

PRICES OF SILVER.

The average monthly price of silver in New York in 1912 was as follows:

Price of silver per fine ounce in New York in 1912, by months.

January	$0.56741	August	$0.62259
February	.59556	September	.63788
March	.58913	October	.64229
April	.59809	November	.63615
May	.61465	December	.64240
June	.61850		
July	.61179	Yearly average	.61470

The average annual New York commercial value of silver per fine ounce for the last 12 years has been:

Annual price of silver per fine ounce in New York, 1901–1912.

1901	$0.60	1907	$0.66
1902	.53	1908	.53
1903	.54	1909	.52
1904	.58	1910	.54
1905	.61	1911	.53
1906	.68	1912	.615

WORLD'S PRODUCTION OF GOLD.

The production of gold in the world from 1860 to 1911, inclusive, is shown in the following table:

Production of gold in the world since 1860.

[The annual production from 1860 to 1872 is obtained from 5-year periods compiled by Dr. Adolph Soetbeer. From 1872 to 1911, inclusive, the estimates are those of the Bureau of the Mint.]

Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.
1860	$134,083,000	1874	$90,750,000	1888	$110,196,900	1902	$296,737,600
1861	122,989,000	1875	97,500,000	1889	123,489,200	1903	327,702,700
1862	122,989,000	1876	103,700,000	1890	118,848,700	1904	347,377,200
1863	122,989,000	1877	113,947,200	1891	130,650,000	1905	380,288,700
1864	122,989,000	1878	119,092,800	1892	146,651,500	1906	402,503,000
1865	122,989,000	1879	108,778,800	1863	157,494,800	1907	412,966,600
1866	129,614,000	1880	106,436,800	1894	181,175,600	1908	442,476,900
1867	129,614,000	1881	103,023,100	1895	198,763,600	1909	454,145,700
1868	129,614,000	1882	101,996,600	1896	202,251,600	1910	454,703,900
1869	129,614,000	1883	95,392,000	1897	236,073,700	1911	461,542,100
1870	129,614,000	1884	101,729,600	1898	286,879,700		
1871	115,577,000	1885	108,435,600	1899	306,724,100	Total.	9,882,386,300
1872	115,577,000	1886	106,163,900	1900	254,576,300		
1873	96,200,000	1887	105,774,900	1901	260,992,900		

In the following table is shown the output of gold, by countries, for the 10 years ending 1911:

World's production of gold, 1902–1911, by countries.

Country.	1902	1903	1904	1905	1906	1907
North America:						
United States	$80,000,000	$73,591,700	$80,464,700	$88,180,700	$94,373,800	$90,435,700
Canada	21,336,700	18,834,500	16,462,500	14,610,400	12,023,900	8,382,800
Mexico	10,153,100	10,677,500	12,605,300	16,107,100	18,534,700	18,681,100
Africa	39,023,700	67,998,100	85,913,900	113,254,700	135,358,000	151,984,100
Australasia	81,578,800	89,210,100	87,767,300	85,926,500	82,391,400	75,677,700
Europe:						
Russia and Finland	22,534,700	24,634,200	24,803,200	22,292,200	19,496,500	26,684,300
Austria-Hungary	2,171,300	2,245,100	2,117,300	2,457,400	2,615,400	2,484,900
Germany	62,500	70,500	64,700	66,700	80,400	66,600
Norway	2,000	2,700	----------	----------	----------	----------
Sweden	62,500	33,900	40,200	36,700	13,300	18,700
Italy	5,300	26,700	44,000	44,000	41,200	39,600
Spain and Portugal	11,500	6,700	----------	----------	----------	----------
Turkey	30,600	20,700	29,000	6,000	6,000	4,500
France	----------	----------	----------	----------	$502,400	$835,400
Great Britain	$77,300	$94,000	$359,800	$112,700	29,200	29,200
Servia	----------	----------	----------	----------	59,800	59,800
South America:						
Argentina	30,000	30,000	9,200	5,500	5,500	103,000
Bolivia	1,000	2,900	21,900	18,800	754,600	1,267,400
Chile	666,900	636,900	636,900	948,500		

World's production of gold, 1902–1911, by countries—Continued.

Country.	1902	1903	1904	1905	1906	1907
South America—Continued.						
Colombia	2,522,600	2,724,400	1,974,400	2,584,000	2,190,800	3,255,600
Ecuador	200,000	274,400	132,900	188,500	294,200	267,100
Brazil	2,099,900	2,280,400	2,043,500	2,044,600	2,403,000	2,020,700
Venezuela	433,800	300,000	300,000	171,400	25,300	22,400
Guiana:						
British	1,808,600	1,611,300	1,608,800	1,690,700	1,607,700	1,304,400
Dutch	322,000	375,900	441,600	632,500	689,200	640,000
French	2,420,200	2,101,500	1,806,400	1,858,900	1,858,900	2,360,800
Peru	2,326,100	592,600	1,329,200	516,100	829,000	514,500
Uruguay	57,800	51,500	25,000	50,000	31,700	51,900
Central America	2,001,900	1,875,300	1,252,500	1,513,400	1,910,700	2,107,800
Asia:						
Japan	1,975,800	2,891,200	2,948,500	3,072,400	2,748,900	2,773,000
China	8,731,800	7,324,700	4,500,000	4,500,000	4,500,000	4,500,000
Indo-China						31,800
Chosen (Korea)	3,000,000	3,000,000	3,000,000	2,593,000	2,283,000	2,170,800
Siam			51,800	48,600	53,200	166,200
India, British	9,588,100	11,428,900	11,722,900	11,950,200	12,087,700	10,383,600
East Indies, British	1,027,100	1,344,800	1,485,300	1,391,200	1,448,700	1,561,300
East Indies, Dutch	474,000	1,409,600	1,414,500	1,414,500	1,254,900	2,079,900
Total	296,737,600	327,702,700	347,377,200	380,288,700	402,503,000	412,966,600

Country.	1908	1909	1910	1911	Total.
North America:					
United States	$94,560,000	$99,673,400	$96,269,100	$96,890,000	$894,439,100
Canada	9,482,100	9,382,200	10,205,800	9,762,100	130,483,000
Mexico	22,371,200	23,842,900	24,910,600	24,880,100	182,763,600
Africa	166,520,500	170,988,600	175,189,900	191,538,400	1,297,769,900
Australasia	73,327,300	71,007,900	65,470,600	60,184,200	772,541,800
Europe:					
Russia and Finland	28,052,200	32,381,300	35,579,600	32,151,600	268,609,800
Austria-Hungary	2,469,300	1,942,000	2,172,600	2,185,100	22,860,400
Germany	64,800	69,200	62,900	62,900	671,200
Norway			1,400		6,100
Sweden	14,500	10,100	2,000	2,000	233,900
Italy	46,500	24,200	29,600	44,800	345,900
Spain and Portugal		2,900	2,800	2,400	26,300
Turkey	2,200	2,200	2,200	500	103,900
France	1,147,400	1,400,600	1,400,600	1,707,100	6,993,500
Great Britain	16,000	21,500	21,500	39,600	800,800
Servia	59,800	150,300		265,300	595,000
South America:					
Argentina	161,300	189,900	173,100	289,000	996,500
Bolivia, Chile	346,300	492,400	463,600	238,100	6,496,200
Colombia	3,427,300	3,179,900	3,370,000	3,167,800	28,396,800
Ecuador	350,300	274,400	249,200	276,800	2,507,800
Brazil	2,196,600	2,252,900	1,954,700	3,834,500	23,130,800
Venezuela	24,500	280,600	340,500	364,800	2,263,300
Guiana:					
British	1,408,100	1,192,700	1,192,700	892,000	14,317,000
Dutch	663,000	621,000	792,600	523,400	5,701,200
French	2,135,500	2,143,800	2,005,800	2,229,100	20,921,700
Peru	514,500	514,500	514,500	455,900	8,106,900
Uruguay	91,600	91,600	91,600	70,600	613,300
Central America	3,018,800	2,630,100	4,657,400	3,360,400	24,328,300
Asia:					
Japan	3,321,600	3,701,800	3,845,400	4,007,500	31,286,100
China	8,647,300	9,352,100	3,658,100	3,314,600	59,028,600
Indo-China	65,600	65,600	65,600	55,000	283,600
Chosen (Korea)	3,047,500	1,993,600	4,399,100	2,889,400	28,376,400
Siam	327,600	327,600	56,500	56,500	1,088,000
India, British	10,598,500	10,358,600	10,718,400	11,054,100	109,891,000
East Indies, British	1,400,900	1,436,900	1,446,800	1,339,400	13,882,400
East Indies, Dutch	2,596,300	2,146,400	3,387,100	3,387,100	19,564,300
Total	442,476,900	454,145,700	454,703,900	461,542,100	3,980,444,400

PRODUCTION OF GOLD AND SILVER SINCE 1792.

According to tables published by the Director of the Mint, the total production of gold and silver in the United States from 1792 to 1912, inclusive, is as follows:

Production of gold and silver in the United States, 1792–1912, by periods, in fine ounces.

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and since by the Director of the Mint.]

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1792–1847	1,187,170	$24,537,000	309,500	$404,500
1848–1872	58,279,778	1,204,750,000	118,568,200	157,749,900
1873–1912	107,519,720	2,222,628,000	1,900,286,900	1,511,015,100
Total	166,986,668	3,451,915,000	2,019,164,600	1,669,169,500

The following table shows the quantity and value of these metals produced in the United States since 1880.

Production of gold and silver in the United States from 1880 to 1912, inclusive, in fine ounces.

Years.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1880	1,741,500	$36,000,000	30,318,700	$34,717,000
1881	1,678,612	34,700,000	33,257,800	37,657,500
1882	1,572,187	32,500,000	36,196,900	41,105,900
1883	1,451,250	30,000,000	35,732,800	39,618,400
1884	1,489,950	30,800,000	37,743,800	41,921,300
1885	1,538,373	31,801,000	39,909,400	42,503,500
1886	1,686,788	34,869,000	39,694,000	39,482,400
1887	1,603,049	33,136,000	41,721,600	40,887,200
1888	1,604,478	33,167,500	45,792,700	43,045,100
1889	1,594,775	32,967,000	50,094,500	46,838,400
1890	1,588,877	32,845,000	54,516,300	57,242,100
1891	1,604,840	33,175,000	58,330,000	57,630,000
1892	1,597,098	33,015,000	63,500,000	55,662,500
1893	1,739,323	35,955,000	60,000,000	46,800,000
1894	1,910,813	39,500,000	49,500,000	31,422,100
1895	2,254,760	46,610,000	55,727,000	36,445,500
1896	2,568,132	53,088,000	58,834,800	39,654,600
1897	2,774,935	57,363,000	53,860,000	32,316,000
1898	3,118,398	64,463,000	54,438,000	32,118,400
1899	3,437,210	71,053,400	54,764,500	32,858,700
1900	3,829,897	79,171,000	57,647,000	35,741,100
1901	3,805,500	78,666,700	55,214,000	33,128,400
1902	3,870,000	80,000,000	55,500,000	29,415,000
1903	3,560,000	73,591,700	54,300,000	29,322,000
1904	3,892,480	80,464,700	57,682,800	33,456,000
1905	4,265,742	88,180,700	56,101,600	34,222,000
1906	4,565,333	94,373,800	56,517,900	38,256,400
1907	4,374,827	90,435,700	56,514,700	37,299,700
1908	4,574,340	94,560,000	52,440,800	28,050,600
1909	4,821,701	99,673,400	54,721,500	28,455,200
1910	4,657,018	96,269,100	57,137,900	30,854,500
1911	4,687,053	96,890,000	60,399,400	32,615,700
1912	4,520,717	93,451,500	63,766,800	39,197,500
Total	93,979,956	1,942,735,200	1,664,093,500	1,259,940,700

IMPORTS AND EXPORTS.

The following table gives a summary of imports and exports of gold and silver during 1912:

Imports and exports of gold and silver during the calendar year 1912.

[Figures furnished by the Bureau of Foreign and Domestic Commerce.]

Metal.	Imports.	Exports.	Excess of—	
			Imports.	Exports.
GOLD.				
Contained in domestic ore and base bullion		$470,333		$470,333
Contained in foreign ore and base bullion	$10,758,866		$10,758,866	
Domestic bullion, refined		26,086,768		26,086,768
Foreign bullion, refined	39,004,035		39,004,035	
United States coin	11,333,854	17,835,183		6,501,329
Foreign coin	5,452,017	3,032,558	2,419,459	
Total	66,548,772	47,424,842	52,182,360	33,058,430
Excess of imports			19,123,930	
SILVER.				
Contained in domestic ore and base bullion		137,752		137,752
Contained in foreign ore and base bullion	24,437,103	1,778	24,345,325	
Domestic bullion, refined		66,614,233		66,614,233
Foreign bullion, refined	20,276,214	4,147,010	16,129,204	
United States coin	2,040,285	232,253	1,808,032	
Foreign coin	1,737,484	828,729	908,755	
Total	48,401,086	71,961,755	43,191,316	66,751,985
Excess of exports				23,560,669

MINES REPORT.

METHOD OF COLLECTING STATISTICS.

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1912 as agreed upon by the Bureau of the Mint and the United States Geological Survey. With the relatively unimportant exceptions of domestic gold and silver contained in ores, mattes, etc., exported for reduction during the year, these figures record the actual production of gold and silver bullion from domestic ores in marketable form as metals, either refined or unrefined.

Owing to the difficulty of tracing this total gold and silver production back to its origin by States, counties, and mining districts, however, the Geological Survey attacks the problem of distribution by systematic investigation of the mine production of ores containing gold and silver during the calendar year, and of the output of the placer mines. In this way the state of the mining industry is studied in detail, and classification of output by methods of production and by kinds of ore, as well as by mining districts, is obtained. The resulting figures form the basis of the mines report.

As already stated, the Bureau of the Mint takes into account, as the basis for figures of production, statistics of gold and silver in unrefined bullion deposited in the United States mints and assay offices, in fine bars of both metals produced by private refineries, and in ores, mattes, etc., exported for treatment.

The data for the mines' report of the United States Geological Survey may be classified as follows: (1) Gold and silver from placers in nuggets, dust, and bullion; (2) gold and silver in mill bullion (obtained by amalgamation, cyanidation, chlorination, etc.) from mills of mine companies treating their own ores, tailings, dumps, etc.; (3) gold and silver in base bullion, matte, etc. (by assay value), from smelters treating their own ores; and (4) gold and silver in crude ore, concentrates, old tailings, slags, etc. (by assay value), shipped to custom mills and smelters—all four of these classes of data being for material treated at the mines or shipped from them during the calendar year.

The first item is the native gold (with silver in natural alloy) produced from placer mines and sold to Government mints and assay offices, and to refineries, banks, and traders. It is difficult to obtain accurate figures for this item only in some parts of Alaska, or from transitory miners elsewhere, or from miners who report only value received for their output. The second and third items cover metal production by mining companies whose mills and smelters treat their own ores and whose products go to the mints and refineries and are covered by confidential mine reports to the Survey. The fourth item, which covers raw mine products shipped for treatment, gives rise to the main apparent discrepancies between mine and mint-refinery reports on the production of gold and silver for the same calendar year. The discrepancies are due largely to the lapse of time between the disposal by shipment of the ore as reported from the mines and its arrival and metallurgical treatment at the mill or smelters, followed by the refining of the products, an interval in which large quantities of metals in ores reported from the mines as shipped in one year may be reported from refineries as produced in marketable form in the following year. For instance, ore shipped in November may be smelted in the following January, and the metal content would be reported from the mines for the calendar year preceding that for which it would be reported in marketable form by the smelters and refineries. The miners furnish the United States Geological Survey with confidential reports on assay values and tonnages of ore and concentrates shipped as the measure of their output, and the mine figures are reported by the Survey so far as possible in terms of recoverable metal; and the smelters and refineries report the metals eventually produced, first as unrefined and finally as refined.

In using the mines report it should be noted that tonnages and metal output given are based not on ore mined but on ore treated or sold during the year. Of course most of the ore treated or sold is also mined during the same year, but some of it is necessarily mined during the preceding year. It must not be overlooked also that the mines' report aims to give the recoverable content, not the assay content, of ore treated or sold. A part of the actual recovery is of course made during the early part of the following year for ores treated or sold late in the year under review, but the basis of the report is essentially metal recovered at whatever time from the tonnage treated or sold during the year covered by the report. For the second and third items enumerated the recovery figures are easily had, as the ore is treated on the ground, and the metal content

of the bullion, either base or unrefined, is readily known. In the third item the refining loss and in the fourth item the combined concentrating, smelting, and refining losses must be considered. In the case of the precious metals the concentrating losses may be large and must be allowed for, but the smelting and refining losses are known to be very small and in ordinary practice to be more than offset by certain gains. These gains are of small quantities of precious metals (not paid for, but actually recovered from ores of copper, lead, and zinc) and certain differences in quantity of gold and silver between actual recovery and basis of settlement—for instance, silver is usually paid for on the basis of 95 per cent of the current New York price and gold at from $19 to $20 per fine ounce. From this it is seen that producers reporting in terms of dollars only will frequently be giving figures corresponding to production below actual final output of metal, and if they erroneously report net proceeds, as they sometimes do, their figures are still further below. Other gains offsetting refining and smelting losses are the relatively small quantities of precious metals, principally gold, not regularly reported from the mines, but coming from transitory placer miners whose production escapes estimate, from stolen ore treated in improvised "assay offices," and from smelter and refinery cleanings and similar material. Although mine reports in the aggregate may appear, therefore, to give figures of gold and silver that are too high, it is known from actual practice and comparison, later discussed, that final recoveries, especially for gold, are somewhat in excess of those reported from the mines.

COMPARISON OF MINT REPORT AND MINES REPORT.

Of the two plans outlined for ascertaining the gold and silver production of the United States it may be said that the one is a measure of the mining industry and the other a measure of the metallurgical industry; the one reports the production and recoverable content of mine output and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results nor should they be expected to do so. In addition to factors already noted as causing differences between the two sets of figures, it must be remembered that it is not always a simple matter for smelters to distribute their output according to the exact origin of the ore, and it is still more difficult for refiners to do so. It is therefore always possible that some ore of Canadian or Mexican origin is contributing to the output of metal thought by smelters to be of domestic origin.

The calendar year covered by both investigations is the same, but the period of mine production naturally corresponds to a period earlier than the period of actual production of marketable metal by the interval of time necessary for transporting, sampling, and treating the ore and for refining the products. This interval is practically negligible in the case of placer and mill bullion, but may be several months in the case of crude smelting ores and especially of ores concentrated before smelting.

The figures for the mint report and the mines report for a period of years sufficiently long to compensate for overlap or lag should agree

within allowable limits of error due to the complex nature of the ores and of the methods of treatment. The figures of the mines report may be expected, on the whole, to fall normally below those of the mint report for the reasons outlined.

For the last eight years the final figures for mint and mine returns have been as follows:

Production of gold and silver, 1905–1912, according to mint and to mine returns.

Years.	Mint.		Mine.	
	Gold.	Silver.	Gold.	Silver.
		Ounces.		*Ounces.*
1905	$88,180,700	56,101,600	$88,159,881	56,272,496
1906	94,373,800	56,517,900	97,219,645	57,362,455
1907	90,435,700	56,514,700	87,471,136	52,500,104
1908	94,560,000	52,440,800	91,914,891	50,878,140
1909	99,673,000	54,721,500	99,438,144	57,315,677
1910	96,269,100	57,137,900	94,933,778	57,598,509
1911	96,890,000	60,399,400	97,054,791	61,108,791
1912	93,451,500	63,766,800	92,880,467	66,041,506
Total	753,833,800	457,600,600	749,072,733	459,077,678

These figures show an excess of gold, according to mint reports, for the eight years of $4,761,067, or a difference of a little over 0.6 per cent, but a deficit of silver production of 1,477,078 fine ounces, or a difference of a little more than 0.3 per cent. As figures for Alaska placers are not claimed to be as close as these, the differences for the United States proper are even lower. It is thought these relatively small differences may be accounted for by the explanations already given. For figures of any one year an excess of mining over smelting and refining, whether of gold and silver or of base metal ore, or both, is indicated by larger figures in the mine reports for gold or silver, or both; and normal relations, or perhaps excess of smelting and refining over mining by drawing upon stocks, is suggested by the reverse figures.

UNITS OF MEASUREMENTS.

Gold and silver are measured by the fine ounce. The computing tables to six decimals used by the Bureau of the Mint and the United States Geological Survey are based on the exact valuation for gold of $20.671834625323 per fine ounce. The average commercial price in New York for silver per fine ounce in 1911 was taken at 53 cents and in 1912 at 61.5 cents. The standard Survey unit for ore production is the short ton of 2,000 pounds.

PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The following table gives the quantity and value of gold and silver, by States, reported from the producing mines in 1912 to the United States Geological Survey. The increase or decrease of production shown results from comparison with the corresponding Survey mine figures for 1911.

Mine production of gold and silver in the United States in 1912 as reported to the United States Geological Survey, by States and Territories, in fine ounces and value.

State or Territory.	Gold.		Silver.		Increase (+) or decrease (—).	
	Quantity.	Value.	Quantity.	Value.	Gold, value.	Silver, quantity.
Alabama	809.02	$16,724	168	$103	— $2,192	— 3
Alaska	829,435.38	17,145,951	515,186	316,839	+ 292,695	+ 54,955
Arizona	181,996.91	3,762,210	3,490,387	2,146,588	+ 331,707	+ 213,816
California	953,639.50	19,713,478	1,300,136	799,584	— 25,430	+ 29,691
Colorado	899,221.69	18,588,562	8,212,070	5,050,423	— 413,413	+ 881,902
Georgia	694.67	14,360	77	48	— 20,710	— 135
Idaho	66,816.23	1,381,214	8,294,745	5,101,268	+ 8,827	+ 98,609
Illinois			4,731	2,909		+ 1,695
Maryland, New Hampshire, and Pennsylvania			502	309	— 9	+ 415
Michigan			528,453	324,999		+ 31,172
Missouri			35,438	21,794		— 14,429
Montana	175,370.74	3,625,235	12,731,638	7,829,957	— 85,336	+ 746,442
Nevada	650,942.71	13,456,180	14,369,063	8,836,974	—4,737,217	+ 1,184,462
New Mexico	37,947.57	784,446	1,536,701	945,071	+ 21,638	+ 182,161
North Carolina	8,030.93	166,014	4,854	2,985	+ 95,732	+ 3,911
Oregon	37,250.73	770,041	57,081	35,105	+ 136,634	+ 11,860
Philippines	27,582.02	570,171	7,121	4,380	+ 377,923	+ 6,221
Porto Rico					— 2,191	— 51
South Carolina	818.26	16,915	47	29	— 3,493	+ 36
South Dakota	381,745.02	7,891,370	206,460	126,973	+ 451,496	+ 2,705
Tennessee	399.82	8,265	89,893	55,284	— 3,356	— 16,767
Texas	3.05	63	406,067	249,731	+ 42	— 18,327
Utah	206,360.54	4,265,851	13,835,903	8,509,080	— 431,147	+ 1,362,116
Virginia	10.54	218	982	604	— 2,846	+ 961
Washington	32,941.63	680,964	413,538	254,326	— 166,713	+ 169,757
Wyoming	1,075.62	22,235	265	163	+ 3,035	— 460
Total	4,493,092.58	92,880,467	66,041,506	40,615,526	—4,174,324	+ 4,932,715
Increase in value, silver						+$8,227,867

A decrease in production of gold of $4,174,324 and an increase in silver output of 4,932,715 fine ounces are shown by the mines reports for the United States for 1912 as compared with the corresponding figures for 1911.

The principal producing States ranked as follows in 1912 in output of gold: California, Colorado, Alaska, Nevada, South Dakota, Utah, Arizona, Montana, and Idaho, or the same as in 1911, except that a small increase in Alaska and a large decrease in Nevada caused them to change places in order of rank, and that a corresponding increase in Arizona and a decrease in Montana caused them to change in 1912 also. No other State besides the nine mentioned has produced over $1,000,000 in gold in the last three years. The most notable increases in gold in 1912 were $451,496 in South Dakota (following an increase of $2,037,617 in 1911), $377,923 in the Philippines, $331,707 in Arizona, and $292,695 in Alaska (following an increase of $726,507 in 1911). The heaviest decreases were $4,737,217 in Nevada (following a decrease of $685,467 in 1911), $431,147 in Utah, and $413,413 in Colorado (following a decrease of $1,505,083 in 1911). Of the 23 geographic divisions given in the table as producing gold in 1912, the output increased in 10 and decreased in 13. In 1911 the production gained in 14 and fell off in but 9.

In silver output the principal producing States ranked as follows in 1912: Nevada, Utah, Montana, Idaho, Colorado, Arizona, New Mexico, and California, or in the same order as in 1911. No other States produced 1,000,000 fine ounces in silver in either year. The

largest increases in silver in 1912 were 1,362,116 fine ounces in Utah (following an increase of 2,006,816 ounces in 1911), 1,184,462 ounces in Nevada (following an increase of 704,730 ounces in 1911), 881,902 ounces in Colorado (following a decrease of 1,179,430 ounces in 1911), and 746,442 ounces in Montana. There were no notable decreases in silver production in 1912. Of the 26 geographic divisions enumerated as producing silver in 1912, there was increased output in 19 and falling off in but 7. In 1911 there was increase in 15 and decrease in 12.

On the whole, therefore, the silver industry made a much better showing than the gold industry in 1912.

MINE PRODUCTION OF GOLD AND SILVER, BY STATES.

ALASKA.

Gold.—The gold production of Alaska in 1912 was $17,145,951, against $16,853,256 in 1911. The output from siliceous ores was $5,002,399, against $4,226,687 in 1911, and that from copper ores was $153,552, against $86,569 in 1911. The production of placers decreased from $12,540,000 in 1911 to $11,990,000 in 1912.

From the Pacific coast belt, including southeastern Alaska and Prince William Sound, the output of gold in 1912 was $4,904,753, against $4,265,573 in 1911; from the Copper River and Cook Inlet regions, $358,401, against $313,538; from the Yukon and Kuskokwim Basins, $8,857,797, against $9,139,145; and from Seward Peninsula and northwestern Alaska, $3,025,000, against $3,135,000. From the first and second of the above-named geographic divisions there were increases in output, therefore, of $639,180 and $44,863, respectively, and from the third and fourth decreases of $281,348 and $110,000, respectively, giving a net increase for Alaska for the year of $292,695, against a corresponding increase of $726,507 for 1911. The increased output of Alaska in 1912 was due chiefly to the increased production from gold-lode mines, particularly of southeastern Alaska, and copper mines. The production also increased slightly from the placers of the Innoko-Iditarod region, but the output of the Hot Springs, Fairbanks, Seward Peninsula, and other placers declined.

A little more than three-fifths of the gold production of Alaska still comes from the placers, but the ratio is declining as the richer gravels are worked out and the output from gold-quartz and copper mines increases. Increased application of dredging to Alaskan placer mining will, however, tend to maintain the placer output at a large figure for many years. The auriferous lode mines of southeastern Alaska produced $4,418,392 in gold in 1912, against $3,904,217 in 1911. The great Treadwell low-grade group of mines in the Juneau district continued to be the heaviest producers. In the Copper River region the great copper deposits were actively developed and increasingly productive. The Fairbanks camp in the Yukon Basin continued to lead all the placer gold districts of Alaska, but the output there decreased from $4,500,000 in 1911 to $4,150,000 in 1912. The placer production of the Hot Springs district of the Yukon declined from $785,000 in 1911 to $400,000 in 1912, but that of the Innoko-Iditarod increased from $2,900,000 in 1911 to $3,000,000 in 1912. Seward Peninsula is estimated to have produced about $3,000,000 in 1912, against $3,100,000 in 1911. Thirty-one dredges were operated in Seward Peninsula,

against 24 in 1911 and 16 in 1910. The daily average capacity of the dredges in 1912 was 1,000 cubic yards, and the average approximate recovery varied from 52 to 64 cents per cubic yard.

The total gold production from gold-lode mines in Alaska since 1882 is estimated at $57,811,300, and the total placer output of Alaska for the same period is estimated at $154,800,848.

It is estimated that there were 720 placer mines operating in Alaska in 1912 against 740 in 1911, and that 6,300,000 cubic yards of gravel were washed in all, by various methods, with an average recovery of $1.87 per cubic yard, against 5,790,000 cubic yards in 1911, with an average recovery of $2.17 per yard.

Silver.—The production of silver in Alaska in 1912 was 515,186 fine ounces against 460,231 ounces in 1911. Of the total production, 376,593 ounces were obtained from copper ores, 102,897 ounces from gold placers, and 35,696 ounces from the siliceous ores of the lode-gold mines.

It is estimated that the total silver production of Alaska since 1882 from auriferous lode mines has been 1,065,439 ounces, and that the total silver recovery from placer gold has been 1,652,016 ounces.

ARIZONA.

Gold.—The gold production of Arizona in 1912 was $3,762,210 against $3,430,503 in 1911 and $3,149,366 in 1910. This was again the largest gold output in the State in recent years, and, as in 1911, the increase was again mainly due to greater production from the gold milling ores of Mohave County and from the copper ores of Cochise County. In output of gold in Arizona Mohave County again led, producing $1,899,131, or half the State total in 1912, against $1,547,663 in 1911. The production is chiefly from the siliceous gold ores of the Gold Road and Tom Reed mines in the San Francisco district. Cochise County again ranked second, with its largest output from the copper ores of the Warren (Bisbee) district. Yavapai County also made an important output from copper ores of the Verde district, and Maricopa a considerable production from the Vulture district. By the amalgamation process $236,345 in gold was produced in Arizona in 1912, and $1,877,241 by cyanidation. Crude ores shipped to smelters contained $1,386,809 of the gold output, and concentrates shipped contained $212,434. Placers in Maricopa, Mohave, Pima, Pinal, Yavapai, and Yuma counties produced $43,046 in 1912, against $23,641 in 1911.

Silver.—The output of silver in Arizona was 3,490,387 fine ounces against 3,276,571 ounces in 1911 and 2,566,528 ounces in 1910. Cochise County alone, and principally from copper ores of the Warren district but also from lead ores of the Tombstone and other districts, produced 1,962,644 ounces in 1912 against 1,946,319 ounces in 1911. Yavapai County again ranked second in output with 748,872 ounces in 1912 against 764,744 ounces in 1911, mainly from copper ores of the Verde district. Gila County ranked third, with 264,941 ounces in 1912 against 247,813 ounces in 1911, mainly from the copper ores of Globe. Mohave County produced 174,343 ounces in 1912, about half of which came from zinc ores, and Pinal County, 109,686 ounces, almost entirely from copper ores. Of the total silver production of Arizona in 1912, copper ores supplied 2,378,593 ounces;

lead ores, 599,110 ounces; and dry and siliceous ores 373,255 ounces. Bullion at gold and silver mills yielded 45,660 ounces of silver in 1912; concentrates smelted, 387,159 ounces; and crude ore smelted, 2,982,049 ounces.

CALIFORNIA.

Gold.—The mine production of gold in California in 1912 was $19,713,478, against $19,738,908 in 1911. The total gold output from placers and from copper, lead, and zinc ores, decreased in 1912, but the production from siliceous ores increased nearly in equal amount, the net falling off for the gold output for the State being only $25,430.

The deep mines yielded $11,067,815 in gold, of which $10,771,759 came from siliceous ores (almost wholly gold milling), $293,946 from copper ores, $1,717 from lead ores, and $393 from zinc ores. The placers produced $8,645,663, of which $689,682 came from hydraulic mines, $7,429,955 from dredges $387.992 from drift mines, and $138,034 from sluicing mines.

The dredges produced 37.68 per cent of the total and 85.93 per cent of the placer yield in 1912. The total dredge output of California for the last 14 years has been $55,415,191 in gold. The dredge output has increased nearly every year, but three decreases being recorded—for 1900, 1907, and 1912. The rate of increase has steadily declined since 1908. The Yuba County field decreased in dredge output by $248,540 in 1912, and Sacramento County by $132,274; but Butte County, as a whole, increased its yield by $20.232, and the Oroville field alone by $92,935.

The leading counties in gold production ranked as follows in 1912: Amador, $2,796,194; Yuba, $2,753,408; Butte, $2,346,229; Nevada, $2,081,958; Sacramento, $1,712,587; Tuolumne, with $1,113,291. The largest increases in output were $272,949 in Kern County, $271,475 in Sierra, and $166,533 in San Bernardino. The largest decreases were $243,664 in Yuba, $205,187 in Inyo, $150,170 in Calaveras, and $146,673 in Shasta. Of the counties named, Yuba, Butte, and Sacramento are essentially dredging counties; Amador, Calaveras, and Tuolumne are Mother Lode counties; Shasta County produces gold mainly from siliceous and copper ores; and Nevada County production is mainly from gold-quartz milling ores of the Grass Valley district. Two of the largest increases, those in Kern and San Bernardino counties. were from the southern part of the State.

The five Mother Lode counties—Amador, Calaveras, El Dorado, Mariposa, and Tuolumne—whose ores are mainly gold quartz, produced altogether in 1912 gold valued at $4,741,497, against $4,877,651 in 1911 and $4,408,990 in 1910. The average total gold and silver recovery per ton from Mother Lode ore in 1912 was $3.69, against $3.57 in 1911, and $3.78 in 1910.

Silver.—The production of silver in California in 1912 was 1,300,136 fine ounces, against 1,270,445 ounces in 1911 and 1,840,085 ounces in 1910. The larger part of the output—792,445 ounces in 1912 and 864,397 ounces in 1911—came from smelting copper ores. The siliceous gold-silver ores produced 409,873 ounces in 1912, and the placers, lead ores, and zinc ores the small remainder. The copper

mines of Shasta County produced 684,381 ounces in 1912, against 706,445 ounces in 1911 and 1,192,520 ounces in 1910. This falling off is due to decreased copper smelting owing to litigation by agricultural interests complaining of smelter fumes. Calaveras County also produced 97,819 ounces from copper ores in 1912, against 107,987 ounces in 1911. Mono County produced 100,291 ounces and San Bernardino County 81,022 ounces of silver in 1912 from silver and silver-gold, dry or siliceous ores. There were 12 silver mines and 25 silver-lead-zinc mines producing argentiferous ores in California in 1912, mainly in Inyo, Kern, Mono, and San Bernardino counties.

COLORADO.

Gold.—The gold production of Colorado in 1912 was $18,588,562, against $19,001,975 in 1911, a decrease of $413,413 from the production of 1911, of $1,918,496 from that of 1910, and of $3,400,774 from that of 1909.

The Cripple Creek district (Teller County) produced $11,008,362 in gold in 1912 (an increase of $445,709), or 59 per cent of the gold output from all sources, or nearly 61 per cent of that from all Colorado deep mines. The San Juan region (Dolores, La Plata, Ouray, San Juan, and San Miguel counties) produced $4,119,191 in 1912, against $5,035,610 in 1911, $5,822,422 in 1910, and $6,170,201 in 1909. Ouray County alone produced $903,368 in gold less than in 1911, this decrease being nearly equal to the decrease for the entire region.

Of the total material treated, dry or siliceous ores yielded $17,391,129 in gold in 1912, or nearly 94 per cent of all the gold output from the State, the value and relative yield being about the same in 1911. Lead ores and placers each supplied about 2 per cent, and the remainder of the output was from copper, copper-lead, and zinc and lead-zinc ores, in three nearly equal parts. The production of placer gold was $423,885, against $319,759 in 1911, the greater part of the output being from Summit County where three dredges and eight other placers were in operation in 1912.

Silver.—The silver production of Colorado in 1912 was 8,212,070 fine ounces, against 7,330,168 ounces in 1911, 8,509,598 ounces in 1910, and 8,902,633 ounces in 1909. Lake County (chiefly the Leadville district) production showed a decrease of 6,899 ounces in 1912, following decreases of 314,719 ounces in 1911 and of 101,627 ounces in 1910; but the county produced 37 per cent of the State yield in 1912, against 41 per cent in 1911, 39 per cent in 1910, and 38 per cent in 1909. Decreases of note were also made in La Plata and Clear Creek counties, but notable increases were recorded from San Juan, Mineral, and San Miguel counties.

Dry or siliceous ores in Colorado yielded 5,397,439 ounces of silver in 1912; lead ores, 1,470,930 ounces; lead-zinc ores, 594,427 ounces; copper-lead ores, 389,449 ounces; copper ores, 224,327 ounces; and zinc ores, 130,392 ounces.

MARYLAND AND PENNSYLVANIA.

Silver.—In Maryland a small production of copper concentrates was made from the New London mine in 1911 and 1912, resulting in a nominal output of silver from refining the copper produced. In Pennsylvania the Cornwall iron mines produce a small quantity of

silver as a by-product from refining copper produced from magnetic separation of the iron ores.

The silver output of Maryland and Pennsylvania combined in 1912 was 502 fine ounces against 87 ounces in 1911.

IDAHO.

Gold.—The gold production of Idaho was $1,381,214 in 1912, against $1,372,387 in 1911. The deep mines produced $749,185 in gold, chiefly from gold and gold-silver siliceous ores but also as a by-product from lead and copper ores. The placers produced $632,029, of which about 76 per cent was won by dredging, and the remainder chiefly by sluicing. At gold and silver mills 12,852.03 fine ounces of gold were produced by amalgamation and 14,163.86 ounces by cyanidation. Crude ore shipped to smelters contained 5,143.40 ounces of gold in 1912, and concentrates 4,004.26 ounces. Boise County led in gold output with $502,277, of which $453,309 was produced chiefly by dredges in the Boise Basin, and was followed by Owyhee County with $289,255, of which $288,465 was produced by deep mines, and by Lemhi County with $225,473, of which $144,379 was produced by deep mines. Dredging has been active in Boise, Lemhi, and Clearwater counties, and production has offset decrease from other sources of gold mining.

Silver.—The production of silver in Idaho in 1912 increased to 8,294,745 fine ounces from 8,196,136 ounces in 1911. A considerable increase was made in output from copper ore, and a large decrease from siliceous ore. The bulk of the output of silver in Idaho is from the lead ore of the great Cœur d'Alene mines in Shoshone County, which produced over 6,650,000 ounces in 1912. Lemhi County also produced nearly 350,000 ounces, almost entirely from lead ores, and ranked second in county output of silver. Shoshone County produced in all 7,558,314 ounces of silver in 1912, of which 378,764 ounces were from copper ores of the Cœur d'Alenes. Of siliceous ores the output was 232,583 ounces, of which 207,835 ounces came from Owyhee County. Crude ore shipped to smelters from Idaho contained 2,679,943 ounces of silver in 1912, and concentrates shipped contained 5,402,543 ounces, of which 4,857,676 ounces were from lead concentrates.

MICHIGAN.

Silver.—The Michigan copper mines produced 528,453 fine ounces of silver in 1912, against 497,281 ounces in 1911. The silver output is mainly from the electrolytic refining of he copper produced, and as this refining may proceed at a different rate from the mining there is no direct relation between the silver production and the mining industry. The average recovery of silver per ton of "rock" treated in 1912 (both conglomerate and amygdaloid) was 0.05 ounce, against 0.04 ounce in 1911 and 0.03 ounce in 1910. Of the total output, Houghton County produced 475,453 ounces in 1912, against 459,715 ounces in 1911; and Keweenaw County, 53,000 ounces in 1912, against 37,053 ounces in 1911.

MISSOURI, ILLINOIS, AND KENTUCKY.

Silver.—The lead and zinc mines of the Central States contribute no gold and but little silver. This last is a by-product, mainly from

the refining of lead from concentrates produced at the lead mines of southeastern Missouri. The silver recovery is about 1 ounce per ton of concentrates saved, and lead from only about one-sixth of the argentiferous ores is desilverized. The output of silver from Missouri in 1912 was 35,438 fine ounces, against 49,867 ounces in 1911, from 31,183 short tons of lead concentrates in 1912, against 51,109 tons in 1911.

In southern Illinois the silver output in 1912 was 4,731 fine ounces from 748 short tons of silver-bearing lead concentrates (recovered from lead-zinc-fluorspar ores), against 3,036 ounces from 482 tons in 1911. The production is incidental to concentrating the fluorspar.

The western Kentucky silver production is also an incidental by-product of lead concentrates obtained from lead-zinc-fluorspar ores, but there was no recovery of silver content reported from this field in 1911 or 1912.

MONTANA.

Gold.—The production of gold in Montana was $3,625,235 in 1912, against $3,710,571 in 1911, a decrease of $85,336. The gold output of Montana from deep mines has been steadily falling off for several years, but the placer output has increased. At amalgamation and cyanidation mills $1,039,471 was produced in 1912, and concentrates and crude ores sent to smelters contained $666,954 and $1,109,255, respectively, in gold. The placer production was $806,419 in 1912, of which $710,387 was from dredging operations chiefly in the Alder Gulch district of Madison County. This county led in gold output in Montana in 1912, chiefly from the placer output, and was followed by Silver Bow County with gold production mainly from the Butte copper ores, and by Fergus, Blaine, and Broadwater counties with output mainly from dry or siliceous gold ores.

Silver.—The silver production of Montana in 1912 was 12,731,638 fine ounces, against 11,985,196 ounces in 1911. The copper ores alone, mainly from the great Butte camp, produced 10,655,055 ounces in 1912; the zinc ores, entirely from Butte, produced 402,679 ounces; and the dry or siliceous ores, mainly from Silver Bow, Granite, and Jefferson counties in nearly equal quantities, produced 1,318,505 ounces. The lead ores produced 266,014 ounces, of which 103,061 ounces came from Cascade County. In county output from all sources, Silver Bow led with 11,352,106 ounces (of the State total of 12,731,638 ounces), and Jefferson County followed with 510,509 ounces and Granite County with 414,831 ounces. The principal silver-producing districts outside of Butte are Elkhorn, in Jefferson County, and Flint Creek, in Granite County.

NEVADA.

Gold.—The production of gold in Nevada in 1912 was $13,456,180, against $18,193,397 in 1911. The largest decrease was of $4,047,328 from the mines of the Goldfield district, following a decrease of $850,075 from the same district in 1911. Another decrease was of $295,935 in Humboldt County, from the mines of the National district, following a similar decrease of $234,772 in 1911. These losses were but little offset by small gains in Churchill, Lincoln, White Pine, Clark, Lander, and Eureka counties, the largest being of $234,164 in Churchill County. Placer and surface mines worked by hydraulic

and sluicing methods and by drift mining produced $231,653 in gold, or $21,192 more than in 1911. The bulk of the placer output is from Manhattan and Round Mountain, in Nye County. By far the greater part of the gold production of Nevada is from amalgamation and cyanidation of the dry or siliceous ores and their concentrates, more than half of which is from Goldfield, in Esmeralda County, and nearly a fourth of which is from Tonopah, in Nye County. Humboldt, Storey (Comstock), and Churchill counties were also important. Copper ores and concentrates, principally of Ely, in White Pine County, and lead ores, principally of the old mining camps of Pioche, in Lincoln County, and Eureka, in Eureka County, supplied the bulk of the small remainder. In county production of gold from all sources, Esmeralda led with $7,014,559, against $11,198,602 in 1911, followed by Nye with $3,123,935, against $3,617,276 in 1911, by Humboldt with $927,779, against $1,223,714 in 1911, and by Storey with $855,494. The output in gold of the Goldfield district alone was $6,239,747 in 1912, against $10,287,075 in 1911, and $11,137,150 in 1910.

Silver.—The silver output of Nevada in 1912 was 14,369,063 fine ounces, against 13,184,601 ounces in 1911, 12,479,871 ounces in 1910, and 10,981,061 ounces in 1909—a steady increase in recent years. Of the total production in 1912, Nye County (chiefly Tonopah) produced 10,210,296 ounces of silver, against 10,918,263 ounces in 1911 and 10,550,303 ounces in 1910—mainly from amalgamation and cyanidation of dry and siliceous ores. These two processes produced 10,002,279 ounces of silver in 1912, of which 9,941,876 ounces came from cyanidation, and of which 8,120,025 ounces were derived from cyaniding Nye County ores alone. At concentration mills 2,301,694 ounces were produced in concentrates in Nevada, of which 2,008,655 ounces were from concentrates of dry or siliceous ores. Copper concentrates contained 75,469 ounces of silver, lead concentrates 11,655 ounces, and lead-zinc concentrates 205,915 ounces. Dry or siliceous ores shipped crude to smelters (mainly from Nye County) contained 1,091,451 ounces in 1912, and crude lead ores smelted carried 348,974 ounces. In total output of silver Nye County led with 10,210,296 ounces, followed by Churchill (including Fairview and Wonder districts) with 1,434,068 ounces, Storey (Comstock) with 806,853 ounces, and Lincoln (including Pioche) with 759,371 ounces.

NEW MEXICO.

Gold.—The gold production of New Mexico in 1912 was $784,446 against $762,808 in 1911. Socorro County alone produced $525,629 in 1912, against $534,253 in 1911, almost wholly from the siliceous ores at Mogollon. Altogether siliceous gold ores furnished $609,884 in New Mexico in 1912, copper ores $150,589, and placers $16,926. The output of gold from siliceous ores materially decreased in 1912, but that from copper ores greatly increased, particularly in Grant County, corresponding to the largely increased copper production of the Lordsburg district.

Silver.—The output of silver in New Mexico in 1912 was 1,536,701 fine ounces, against 1,354,540 ounces in 1911 and 843,987 ounces in 1910. Socorro County produced 1,126,429 ounces in 1912, against 1,109,945 ounces in 1911, chiefly from siliceous ores of the Mogollon district. Grant County supplied 356,057 ounces, chiefly from silic-

eous, copper, and lead ores. The Chino copper ores of Grant County are exceptionally low in their silver content, but copper ores, chiefly from this county, produced 290,568 ounces of silver in 1912 Siliceous ores from the entire State produced 1,141,786 ounces, or 74 per cent of the total.

OREGON.

Gold.—The gold production of Oregon in 1912 was $770,041, against $633,407 in 1911, an increase of $136,634. The largest yield of gold came, as usual, from Baker County, whose output was $484,041, an increase of $94,255. The next county in rank was Josephine, with $76,061, followed by Jackson with $62,985. Baker County produced $446,207 from siliceous ores and $37,834 from placers, and Josephine County produced $17,842 from siliceous ores and $58,219 from placers. The total output of deep mine gold was $580,945 and that from placers was $189,096. Southwestern Oregon produced $217,565 in gold in 1912, against $188,971 in 1911, and northeastern Oregon produced $552,476 against $444,436 in 1911.

Silver.—The output of silver in Oregon in 1912 was 57,081 fine ounces, against 45,221 ounces in 1911. Baker County, in northeastern Oregon, produced 39,140 ounces, a considerable gain over the output in 1911. The deep mines of the State yielded 55,140 ounces, of which 10,555 ounces came from copper ores and the greater part of the remainder from siliceous ores.

SOUTH DAKOTA.

Gold.—The production of gold in South Dakota in 1912 was $7,891,370, against $7,439,874 in 1911, and was the largest ever recorded from the State. The total output of gold in South Dakota from 1875 to 1912, inclusive, has been $170,634,838. The yield is wholly from siliceous ore and the greater part of this is low-grade, milling, amalgamating-cyaniding ore. Mining and metallurgical practice of highest grade have been characteristic of the successful operation of South Dakota gold mines, particularly of the great Homestake mines and mills of Lawrence County, which have produced the bulk of the output. The Homestake mines and mills were operated continuously in 1912, and, with the exception of the Mogul mill which was burned in March, all the other large properties were continuously operated also. The dredge at Mystic, in Pennington County, made a slightly increased output.

Silver.—The silver production of South Dakota in 1912, mainly from refining gold bullion, was 206,460 fine ounces, against 203,755 fine ounces in 1911.

SOUTHERN APPALACHIAN STATES.

Gold.—The combined gold production of Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia in 1912, was $222,496, against $159,361 in 1911. North Carolina maintained the lead with $166,014 in 1912, against $70,282 in 1911, followed by South Carolina with $16,915, Alabama with $16,724, and Georgia with $14,360. The output was mainly from gold-quartz ores and placers, in both of which North Carolina led in output. Tennessee contributed the bulk of the small yield from copper ores.

Silver.—The silver output of the Southern States was 96,523 fine ounces in 1912, against 108,105 ounces in 1911. Of the total yield the copper ores of the Ducktown district in Tennessee furnished 89,893 ounces, the lead-zinc ores of North Carolina 2,394 ounces, and the gold-quartz ores of the same State 1,902 ounces in 1912.

TEXAS.

The gold production of Texas is merely nominal and a by-product, being $63 in 1912 and $21 in 1911. The output of silver was 406,067 fine ounces in 1912, against 424,394 ounces in 1911. This production is almost wholly from the milling of oxidized dry or siliceous ores of the Shafter district in Presidio County.

UTAH.

Gold.—The gold production of Utah in 1912 was $4,265,851, a decrease of $431,147, or about 10 per cent, from the output of $4,696,998 in 1911. The largest production was from Juab County, which yielded $1,804,842 in 1912, against $1,500,359 in 1911. The Tintic district, partly in Juab and partly in Utah counties, produced $1,900,731 in gold in 1912, or 44 per cent of the State yield, principally from dry and siliceous copper and lead ores. The Bingham district, in Salt Lake County, with its enormous output of copper ores, ranked second in gold yield in 1912, with a production of $1,785,532, or about 42 per cent of the total output. Tooele County produced $450,632 in gold in 1912, against $584,917 in 1911, mainly from siliceous ores. In the Camp Floyd district of this county the Consolidated Mercur mine has for nearly a quarter century been a large producer of gold, but the end of 1912 saw practically the exhaustion of the ore bodies. Placer gold milling and amalgamation was practiced in Boxelder and Iron counties in 1912, and recovery by cyanidation was made in Salt Lake and Tooele counties. These two processes together produced $440,073 in gold from 171,117 tons of ore and 250 tons of old tailings treated, from which the average extraction was $2.57 per ton. The recovery by amalgamation averaged $5.20 per ton in 1912, against $3.23 in 1911, and the extraction by cyanidation was $2.56 per ton treated in 1912, against $2.29 in 1911. The total recovery by both amalgamation and cyanidation was $626,609 in 1911, and $754,127 in 1910—a steady decrease. The remainder and bulk of the gold production of Utah is chiefly from the smelting of copper, lead, and dry ores and concentrates, the chief source being copper ores and concentrates and dry and lead ores. The placer output of Utah in 1912 was $5,680, from Uinta, Garfield, San Juan, and Grand counties, against $57,634 in 1911.

Silver.—The silver output of Utah in 1912 was 13,835,903 fine ounces, against 12,473,787 ounces in 1911 and 10,466,971 ounces in 1910. Juab County produced 6,638,425 ounces in 1912, against 4,673,698 ounces in 1911 (mainly from dry or siliceous, copper, and lead ores), and Utah County produced 531,478 ounces in 1912, against 934,768 ounces in 1911 (chiefly from dry and lead ores). The Tintic district (lying in both counties) increased its output of silver from 5,514,702 ounces in 1911 to 7,073,104 ounces in 1912. Salt Lake County produced 2,218,822 ounces in 1912, against 2,947,481 ounces in 1911 (mainly from copper and lead ores). The West Mountain or

Bingham district in this county yielded 2,028,496 ounces in 1912, against 2,786,810 ounces in 1911. Summit County produced 2,954,028 ounces, against 2,882,825 ounces in 1911, chiefly from lead ores but also from lead-zinc ore and in small quantity from siliceous ores. The Park City region, lying mainly in Summit County but also in Wasatch County, produced 3,642,749 ounces of silver in 1912 (from lead and lead-zinc ores), an increase of 214,098 ounces over the output of 1911. Of the total silver production of Utah, mainly the result of smelting, 2,247,050 ounces came from lead concentrates, 5,073,891 ounces from crude lead ore shipped, 3,410,636 ounces from dry and siliceous crude ore, and 2,187,869 ounces from crude copper ore shipped to smelters in 1912.

WASHINGTON.

Gold.—The gold output of Washington in 1912 was $680,964, against $847,677 in 1911. The decrease of $166,713 was reported due to changing conditions of metallurgy (not fully completed) at Republic district, in Ferry County. More than 97 per cent of the gold production came from siliceous ore, chiefly from Ferry County. Crude ore shipped to smelters produced $515,362 in gold in the State in 1912, and mill bullion contained $160,694. The output of Ferry County was $605,698 in gold, against $778,526 in 1911, and of these amounts the Republic district supplied $594,873 in 1912, against $772,874 in 1911.

Silver.—The silver production of Washington was 413,538 fine ounces in 1912, against 243,781 ounces in 1911, the gain being due to increased quantities of crude copper ore shipped to smelters almost entirely from the Chewelah district, in Stevens County. The siliceous ores of Ferry County contributed 152,224 fine ounces of silver in 1912.

WYOMING.

Gold.—The production of gold in Wyoming in 1912 was $22,235, against $19,200 in 1911. Of this output $21,449 came from siliceous ores of deep mines, against $12,159 from this source in 1911, and $766 came from placers, against $7,041 from placers in 1911. A nominal quantity of gold was derived from copper ores in 1912. The principal output of gold was from the Atlantic City (South Pass) district, which produced mill bullion, cyanide precipitates, and placer bullion. The Shoshoni dredge, on Bighorn River, was closed down after a short trial run and operations were discontinued.

Silver.—The silver production of Wyoming was 265 fine ounces, against 725 ounces in 1911. The output was mainly from siliceous and copper ores. The Rambler copper mine, in Albany County, again produced copper ores carrying platinum and palladium in commercial quantities.

PHILIPPINE ISLANDS.

Gold.—The gold production of the Philippines was $570,212[1] in 1912, against $189,953 in 1911. The output is almost wholly from gold-quartz ores and from placers. Dredging in the Paracale district of southeastern Luzon has been of growing importance, and the production of gold from oxidized ores by the well-equipped plant of the

[1] Press Bulletin No. 16, Bureau of Science, Manila, June 6, 1913.

Colorado mine, in the Aroroy district of Masbate, has been of particular interest. The gold-quartz district of Benguet, in north-central Luzon, has been relatively quiet.

Silver.—The production of silver in the Philippines was 7,121 fine ounces in 1912, against 3,383 ounces in 1911. The output is from the refining of gold bullion produced from quartz and placer mines.

NUMBER OF PRODUCING MINES.

The following table indicates the number of mines producing gold and silver in 1912, divided into placers and deep mines. The placers are those in which gold, the silver in natural alloy with the gold, and in a few instances platinum are recovered from gravels and sands, whether by hand-washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or dredging. The deep mines are those producing gold and silver mainly from underground workings, including those whose ores are valuable chiefly for copper, lead, or zinc, but which contribute precious metals as by-products. In addition to the producing mines here enumerated, many "mines" were being prospected and developed without making an output in 1912, and annual assessment work (required by law to hold claims not patented) was done on a very much greater number of new or old, worked-out, or indefinitely idle properties, once productive or otherwise, and of mere mining claims, which have not yet become "mines."

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and because the production is frequently by transitory miners not regularly working placer ground. The unit, so far as possible is, however, as for deep mines, not the operator, but the mining claim, or group of claims.

Number of producing mines in 1912, by States and Territories.[a]

State or Territory.	Number of mines.		
	Placer.	Deep.	Total.
Alabama	.....	3	3
Alaska	720	32	752
Arizona	51	394	445
California	509	532	1,041
Colorado	33	856	889
Georgia	23	5	28
Idaho	235	173	408
Maryland and Pennsylvania	.....	3	3
Michgan [b]	.....	8	8
Missouri [b]	.....	4	4
Montana	152	452	604
Nevada	63	641	704
New Mexico	26	119	145
North Carolina	22	14	36
Oregon	156	54	210
South Carolina	5	7	12
South Dakota	19	21	40
Tennessee [c]	.....	2	2
Texas	.....	3	3
Utah	9	198	207
Virginia and New York [c]	.....	4	4
Washington	12	34	46
Wyoming	9	8	17
Total	2,044	3,567	5,611
Total 1911	2,146	3,553	5,699

[a] Illinois, Philippines, and Porto Rico not included.
[b] Number of mines contributing to silver production in 1912.
[c] Number of mines contributing to gold and silver production in 1912.

The table shows the number and distribution of mines producing gold and silver in the United States and Alaska. With the exception of (1) some of the Michigan copper mines, (2) all zinc mines in the Eastern and Central States and a few in the far West, and (3) all lead mines of the Central States (except a few in Illinois and southeastern Missouri), practically all mines producing copper, lead, and zinc in the United States and Alaska yield gold and silver also. The table, therefore, with these exceptions, is a table of mines producing gold, silver, copper, lead, and zinc in the United States. It also includes certain mines producing oxidized manganese-iron fluxing ores of Colorado, Utah, and elsewhere, whose ores contain small quantities of precious metals, especially silver, and are sold to western smelters as flux.

Comparisons with corresponding figures for 1911 show a net total decrease of 88 producing mines in 1912. The number of placers decreased by 102 and the number of deep mines increased by 14. In 1911 the number of deep mines increased by 254 and the number of placers by 120. In 1910 the number of deep mines increased by 116 and the number of placer mines decreased by 161. For the last seven years the number of producing mines has been as follows:

Number of mines producing gold and silver, 1906–1912.

Year.	Placer.	Deep.	Total.
1906	2,316	2,114	4,430
1907	2,586	2,604	5,190
1908	2,599	2,864	5,463
1909	2,187	3,183	5,370
1910	2,026	3,299	5,325
1911	2,146	3,553	5,699
1912	2,044	3,567	5,611
Average	2,272	3,026	5,298

The figures show that fewer placer mines were producing in each of the last four years than the average of the period, but they also show a steady increase in deep mines. The enumeration of placer mines presents certain difficulties, as noted above, and it has been especially difficult in Alaska in earlier years.

In Alaska the estimate of producing placer mines was 740 in 1911, and 720 in 1912, and there were 26 operating deep mines in 1911 and 32 in 1912. In Arizona the number of placers increased from 42 to 51 and the number of deep mines from 355 to 394. In California there were 509 placers and 532 deep mines in 1912, against 585 placers and 596 deep mines in 1911. In Colorado the number of placers decreased from 39 in 1911 to 33 in 1912 and the number of deep mines from 861 to 856. In Idaho the placers increased in number from 217 to 235, and the deep mines from 157 to 173. In Montana there was a decrease from 180 placers and 530 deep mines in 1911 to 152 placers and 452 deep mines in 1912. In Nevada the number of operating placers decreased from 72 to 63, but the deep mines increased from 589 to 641. In New Mexico the placers increased from 20 to 26 and the deep mines from 85 to 119. In Oregon there were increases also in number of placers from 136 to 156 and of deep mines from 40 in 1911 to 54 in 1912. In South Dakota, Utah, and Wyoming there was

little change; but in Washington the number of producing placers fell from 24 to 12 and the deep mines from 36 to 34. In the Central States there are no placers and the small number of deep mines producing precious metals varies little from year to year. In the Eastern States the numbers of producing placers and deep mines were the same in 1912 as in 1911.

In total number of producing mines California led with 1,041, followed by Colorado with 889, Alaska with 752, Nevada with 704, Montana with 604, Arizona with 445, and Idaho with 408. The order was the same in 1911, except that Montana preceded Nevada.

ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUES.

The best index of deep mining is, of course, the tonnage, content, and value of ore mined, rather than the number of mines or of operators. In the next following table is given the ore production, by classes of ore and by States and Territories, of mines producing gold and silver and the average extraction value of precious metals per ton.

The clasification adopted is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals. The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ores are both relatively very small. The copper ores include those containing over 2½ per cent of copper, or less than this in the cases of the great disseminated copper deposits of the West and of the Lake Superior ores; the lead ores are those containing 4½ per cent or more of lead, and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious metal content. The mixed ores are combinations of the ones enumerated.

Ore production in short tons and average extraction value of gold and silver per ton in 1912, by States and Territories.[a]

State and Territory.	Dry or siliceous ores.		Copper ores.		Lead ores.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama and Georgia	7,052	$4.43				
Alaska	1,761,814	2.85	93,452	$4.11		
Arizona	250,142	10.18	6,542,154	.41	20,960	$23.85
California	2,225,429	4.95	408,622	1.91	974	24.18
Colorado	1,966,300	10.53	13,718	23.26	182,745	7.18
Idaho	88,430	8.60	98,848	3.24	1,597,661	2.78
Maryland and Pennsylvania			225,200	.0014		
Michigan [b]			2,500,000	.211		
Montana	298,308	9.56	5,094,432	1.42	20,993	9.94
Nevada	1,400,728	14.74	3,276,169	.18	59,452	11.52
New Mexico	117,167	11.24	1,195,683	.275	6,852	7.11
North Carolina	14,358	10.62	500	2.25		
Oregon	86,353	6.84	4,569	4.21	23	202.90
South Carolina	12,358	1.34				
South Dakota	1,901,459	4.21			267	15.66
Tennessee [c]			603,229	.105		
Texas	20,728	11.99	22	.50	7	131.00
Utah	369,736	9.78	6,670,845	.56	498,401	8.67
Virginia and New York [c]	45	2.98	1,160	.52		
Washington	62,086	12.46	32,632	4.72	263	11.65
Wyoming	2,284	9.43	155	.59		
Total, 1912	10,584,777	7.40	26,761,390	.63	2,388,598	4.85
Percentage of tonnage	25.76		65.12		5.82	
Total, 1911	10,623,884	7.50	21,384,408	.67	2,157,817	4.39
Percentage of tonnage, 1911	29.91		60.20		6.07	

State and Territory.	Zinc ores.		Copper-lead and copper-lead-zinc ores.		Lead-zinc ores.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Alabama and Georgia							7,052
Alaska							1,855,266
Arizona	22,321	$5.30	315	$41.98	4,190	$8.60	6,840,082
California	6,472	2.59					2,641,497
Colorado	177,946	.51	6,810	41.05	229,107	2.17	2,576,626
Idaho	1,236	.30	33	64.97	480,126	.68	2,266,334
Maryland and Pennsylvania							225,200
Michigan [b]							2,500,000
Montana	136,552	1.98	1,788	28.93	91	19.23	5,552,164
Nevada	7,394	.05	168	16.08	20,054	6.40	4,763,965
New Mexico	16,394	.04	398	6.17	15,792	1.21	1,352,286
North Carolina					1,215	5.33	16,073
Oregon							90,945
South Carolina							12,358
South Dakota							1,901,726
Tennessee [c]							603,229
Texas					351	.73	21,108
Utah	9,422	1.20	5,102	19.27	216,764	4.48	7,770,270
Virginia and New York [c]							1,205
Washington							94,981
Wyoming							2,439
Total, 1912	377,737	1.35	14,614	30.80	967,690	2.05	41,094,806
Percentage of tonnage	0.92		0.03		2.35		100.00
Total, 1911	425,380	.89	6,923	25.17	924,478	1.80	35,522,890
Percentage of tonnage, 1911	1.20		0.02		2.60		100.00

[a] Illinois, Missouri, the Philippines, and Porto Rico not included; crude ore tonnage, containing precious metals not known.
[b] Includes only copper ore yielding precious metals.
[c] Lead and zinc ores yielded no precious metals.

The total quantity of ore sold or treated in 1912 and producing gold and silver was 41,094,806 short tons, against 35,522,890 tons in 1911 and 31,717,912 tons in 1910.

The total output of dry or siliceous ores decreased slightly, from 10,623,884 tons in 1911 to 10,584,777 tons in 1912, and the percentage of the total of this class of ore fell from 29.9 to 25.8 The average precious metal value also decreased from $7.50 to $7.40 per ton. All these percentage and value decreases are in continuation of similar decreases in 1911 and indicate a downward movement in relative tonnage and average value of these ores. The latter change is the more significant when the higher price of silver in 1912 is taken into account.

Of the total output of 10,584,777 tons of dry and siliceous ores, the bulk were gold-silver ores, but 848,574 tons were true silver ores. Of these, 158,429 tons were produced in Colorado, 476,725 tons in Nevada, 110,127 tons in New Mexico, 20,375 tons in Texas, 81,234 tons in Utah, and smaller quantities in Arizona, California, Idaho, Montana, Oregon, and Washington, in 1912.

The quantity of copper ores treated increased from 21,384,408 tons in 1911 to 26,761,390 tons in 1912, following a similar increase in 1911. The average precious metal content decreased, however, from $0.67 to $0.63, following a similar decrease since 1910. These figures are in harmony with the increase in relative output of copper ores, from 60.2 per cent of the total in 1911 to 65.12 per cent in 1912, owing to the largely increased output of low-grade ores in recent years.

The output of argentiferous lead-ores increased also from 2,157,817 tons in 1911 to 2,388,598 tons in 1912, but the relative production of these ores decreased from 6.07 to 5.82 per cent of the total, both of these changes being in continuation of corresponding changes in 1911. The average precious metal value of the ore increased from $4.39 to $4.85, more than offsetting a decline in 1911 from $4.44 in 1910.

The production of gold and silver bearing zinc ores decreased from 425,380 to 377,737 tons, and the relative output from 1.20 to 0.92 per cent of the total, but the average precious metal value increased from $0.89 to $1.35. All of these changes were opposite to those of 1911.

The output of copper-lead and copper-lead-zinc ores increased from 6,923 to 14,614 tons, and the average precious metal tenor from $25.17 to $30.80 per ton. These ores have the highest average richness of all in precious metal but they form only 0.03 per cent of the total output of ore that yields gold and silver. The production of lead-zinc ores increased from 924,478 to 967,690 tons and the average precious metal tenor from $1.80 to $2.05 per ton, but the relative percentage of output of these to total ores decreased from 2.60 to 2.35 per cent.

The production of dry and siliceous ores increased from 1,594,404 to 1,761,814 tons in Alaska, from 1,874,103 to 1,966,300 tons in Colorado, and from 1,341,495 to 1,400,728 tons in Nevada. It decreased from 2,296,347 to 2,225,429 tons in California, from 1,945,770 to 1,901,459 tons in South Dakota, from 369,241 to 298,308 tons in Montana, and from 464,229 to 369,736 tons in Utah. The great output of this class of ore is notable from Alaska, California, Colorado, Nevada, and South Dakota, and is mainly from the well-known Treadwell, Mother Lode and Grass Valley, Cripple Creek, Goldfield and Tonopah, and Homestake mines, respectively, in these States.

The output of copper ores increased from 4,274,209 to 6,542,154 tons in Arizona, from 2,375,000 to 2,500,000 tons in Michigan, from 4,332,479 to 5,094,432 tons in Montana, from 2,778,325 to 3,276,169 tons in Nevada, from 69,305 to 1,195,683 tons in New Mexico, from 581,974 to 603,229 tons in Tennessee, and from 6,121,099 to 6,670,845 tons in Utah. There was no important decrease of copper-ore output in 1912. The great production from Utah, Nevada, New Mexico, and in part from Arizona is largely from disseminated deposits, that of Butte (Montana) from fissure deposits, and that of Michigan from the amygdaloid and conglomerate deposits of the Keweenaw districts.

The output of precious-metal-bearing lead ores increased from 158,984 to 182,745 tons in Colorado, from 1,559,724 to 1,597,661 tons in Idaho, and from 393,029 to 498,401 tons in Utah. There were smaller increases in Montana and Nevada also, and no important decreases in 1912. The production of argentiferous zinc ores increased from 110,845 to 177,946 tons in Colorado, but decreased from 225,586 to 136,552 tons in Montana. The production of argentiferous lead-zinc ores increased from 214,385 to 229,107 tons in Colorado and from 397,354 to 480,126 tons in Idaho, but decreased from 280,817 tons to 216,764 tons in Utah.

The average extraction value of precious metals per ton of dry or siliceous ore increased in Alaska from $2.66 in 1911 to $2.85 in 1912, in California from $4.57 to $4.95, and in South Dakota from $3.87 to $4.21; but it decreased in Colorado from $11 to $10.53, and in Nevada from $18.12 to $14.74.

The average extraction value of gold and silver per ton in copper ores increased from $0.111 in 1911 to $0.211 in 1912 in Michigan, and from $1.32 to $1.42 in Montana, remained the same at $0.18 in Nevada in both years, and decreased from $0.51 to $0.41 in Arizona, from $1.70 to $0.275 in New Mexico, and from $0.60 to $0.56 in Utah. The average precious-metal value of lead ores increased from $2.45 to $2.78 in Idaho, but decreased from $9.55 to $8.67 in Utah. In zinc ores the value increased from $0.30 to $0.51 in Colorado, and from $1.23 to $1.98 in Montana. In lead-zinc ores the value increased from $2.16 to $2.17 in Colorado, and from $2.93 to $4.48 in Utah, but decreased from $0.70 to $0.68 in Idaho.

AVERAGE TENOR OF SILVER IN ORES, BY MINING DISTRICTS.

In the general Survey report on gold and silver by the writer for 1911 the results were given of a brief study of the tenor of silver in ores by mining districts. A few copies of that report are still available for distribution.

The bulk of the silver production, as shown, is from more widely distributed sources than that of gold, the placers and mixed ores playing little part, but the dry or siliceous silver, silver-gold, and gold-silver ores, the copper ores, and the lead ores contributing more equally in the product. The relatively high tenor of many dry or siliceous and lead ores (with the notable exception of the lead ores of the Cœur d'Alene) are shown, as well as the relatively high tenor of silver in the copper ores in the Chitina region, Alaksa, and the Lead-

ville, Tintic, and Chewelah districts in the United States. The relatively low silver content of the Clifton, Ray, and Ely copper ores, and especially of the Santa Rita (Chino) copper ores, is also notable.

DISTRIBUTION OF GOLD PRODUCTION OF 1912, BY SOURCES.

As shown in the following tables, the great bulk of the gold output is from dry or siliceous ores—normally gold-quartz ores—and placers, about 92 per cent of the total gold production coming from these two sources alone. The total output of gold derived from the great copper, lead, and zinc mines of the United States is therefore comparatively small. The changes in relative output from the various sources given in the table have been unimportant during the last three years. It is interesting to note, however, the gradual increase in relative placer output from 23.76 per cent in 1910, to 24.17 per cent in 1911, and to 24.94 per cent in 1912, also corresponding decreases in relative output from dry or siliceous ores from 68.91 per cent in 1910 to 68.52 per cent in 1911, and to 67.29 per cent in 1912. Normally, changes would be expected in the opposite direction.

The following table shows the sources by classes of ore, by States, of the gold production of 1912, and for comparison the corresponding figures for 1911 are given:

Source of gold in 1912 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama	.....	809.02	.....	.....	.....	.....	.....	809.02
Alaska	580,016.25	241,991.05	7,428.08	.....	.....	.....	.....	829,435.38
Arizona	2,082.35	112,067.76	57,507.81	6,363.49	3,126.18	84.03	765.29	181,996.91
California	418,233.95	521,083.83	14,219.65	83.06	19.01	.....	.....	953,639.50
Colorado	20,505.45	841,295.86	8,759.83	19,766.81	532.51	1,936.59	6,424.64	899,221.69
Georgia	331.18	363.49	.....	.....	.....	.....	.....	694.67
Idaho	30,574.40	29,856.42	2,039.30	3,854.52	.....	.....	491.59	66,816.23
Montana	39,010.52	98,779.72	34,200.83	2,181.28	1,096.32	102.07	.....	175,370.74
Nevada	11,206.22	608,132.86	23,511.60	8,085.83	4.26	1.94	.....	650,942.71
New Mexico	818.79	29,503.13	7,284.74	309.60	.....	3.43	27.88	37,947.57
North Carolina	423.38	7,321.95	43.68	.....	.....	.....	241.92	8,030.93
Oregon	9,147.52	27,277.97	616.40	208.84	.....	.....	.....	37,250.73
South Carolina	20.27	797.99	.....	.....	.....	.....	.....	818.26
South Dakota	663.95	381,034.88	.....	46.19	.....	.....	.....	381,745.02
Tennessee	.....	.....	399.82	.....	.....	.....	.....	399.82
Texas	.....	2.00	.24	.32	.49	.....	.....	3.05
Utah	274.77	71,243.22	105,720.03	24,310.76	102.17	171.58	4,538.01	206,360.54
Virginia	.....	10.54	.....	.....	.....	.....	.....	10.54
Washington	228.71	32,054.63	655.30	2.99	.....	.....	.....	32,941.63
Wyoming	37.06	1,037.61	.95	.....	.....	.....	.....	1,075.62
Total 1912	1,113,574.77	3,004,663.93	262,388.26	65,213.69	4,880.94	2,299.64	12,489.33	4,465,510.56
Value	$23,019,633	$62,111,916	$5,424,047	$1,348,087	$100,898	$47,538	$258,177	$92,310,296
Percentage of total	24.94	67.29	5.86	1.46	0.11	0.06	0.28	.....
Total 1911	1,132,708.78	3,210,610.00	263,647.58	58,127.71	2,110.33	1,123.22	17,291.90	4,685,619.52
Value	$23,415,168	$66,369,199	$5,450,079	$1,201,606	$43,624	$23,221	$357,455	$96,860,352
Percentage of total	24.17	68.52	5.63	1.25	0.04	0.02	0.37	100.00

[a] Philippines and Porto Rico not included.

PLACERS.

The total value of the gold placer production was $23,019,633 in 1912, against $23,415,168 in 1911. These figures represent 24.94 per cent of the total domestic gold output for 1912 and 24.17 per cent of that for 1911. The placer production of Alaska was $11,990,000 in 1912, against $12,540,000 in 1911, and that of California was $8,645,663 in 1912, against $8,986,527 in 1912.

Dredging supplied $11,218,804 in 1912 and $10,311,589 in 1911. Of this California produced $7,429,955 in 1912, against $7,666,461 in 1911. The total production of gold by dredging in California to the end of 1912 was $55,415,191. In 1912 Alaska produced $2,200,000 by dredging, against $1,500,000 in 1911 and $800,000 in 1910. The gold output by dredges and the number of boats producing in 1912 and 1911 is shown in the following table:

Gold output in the United States in 1911 and 1912, in dollars, and number of dredges producing, by States.

State or Territory.	1911		1912	
	Output.	Number dredges.	Output.	Number dredges.
Alaska	$1,500,000	27	$2,200,000	38
California	7,666,461	65	7,429,955	65
Colorado	272,173	4	384,748	3
Idaho	243,965	7	480,970	8
Montana	597,824	9	710,387	6
Oregon	14,575	3	.....	.....
Other States [a]	16,591	5	12,744	4
Total	10,311,589	120	11,218,804	124
Increase 1912	.....	.....	907,215	4

[a] South Dakota, Georgia, Wyoming, and North Carolina, 1 dredge each.

The remainder of the placer production is chiefly from drift mining (which is of decreasing importance in Alaska in frozen ground at no great depth, but of continued importance in California in ancient buried river channels, often at considerable depth) and from hydraulic and sluicing placers. In California, especially, hydraulic mining has been of much importance in the past and a special branch of the industry in itself, but restrictive laws relative to the débris and to disturbance of navigable streams have in recent years greatly confined mining activity of this kind. Finally, there is also a small annual output of gold from dry placers of the Southwest, and a considerable production of gold and platinum from ocean beach mining in California and Oregon. The following notes have been taken from the Survey report on precious and semiprecious metals in California and Oregon, in 1912, by Charles G. Yale, published in volume 1 of Mineral Resources of the United States for that year:

BEACH MINING IN CALIFORNIA AND OREGON.

By Charles G. Yale.

California.—A form of gold mining somewhat peculiar to the Pacific coast, and a source of gold production in California, is mining the heavy black sand of the ocean beaches, especially near the mouths of rivers draining areas which carry auriferous gravels. These beaches are worked intermittently, more particularly after winter

storms, when the overburden of ordinary beach sand has washed away, leaving the black and heavier sand behind. The sands are dug up and washed in "toms" or sluices, or are handled by concentrators.

Additional interest has been taken lately in such of these beaches as yield platinum as a by-product of the gold. Three miles south of Crescent City, Humboldt County, the present beach is very wide and has long been known to carry values in gold and platinum. Repeated efforts to extract these values have previously met with failure. Within the last year, however, a large plant with an improved system of concentration has produced a considerable amount of gold, platinum, and iridosmine, while working in the flat back of the sand dunes of the beach where well protected from storms. Here a tract of more than 100 acres is said to yield over $1 per cubic yard on the average from the surface to a depth of 15 feet, which is the greatest depth to which mining has been carried.

While many beaches containing gold and platinum are known at several widely separated points on the California coast line, notably at Little River, Humboldt County; Aptos, Monterey County; Surf and Lompoc, Santa Barbara County, no mining is in progress except some prospecting at Little River. For many years experiments have continued to be made to work these beach deposits on a large scale by various methods, but the business still remains one of small proportions as far as total amount of product annually is concerned.

Oregon.—The high price of platinum in 1912 called more attention to such gold-bearing sands near the mouths of the estuaries as contain significant amounts of platinum as a by-product of the ocean beach gold mining. Thus the beach inside of Coos Bay Head, on Coos Bay, Oreg., is being worked for testing a centrifugal machine which is to throw both gold and platinum on the surface of carpeting with which the machine is lined. Ultimate success depends on the method of gathering the sand which is said to be quite rich on, and for a foot above, the shale bedrock, which is exposed and involves no stripping. The old beach at Whisky Run, Coos County, has been worked by various devices and usually with success. Lately it has been acquired with much adjacent high beach land for work on a large scale with a traveling beach dredge capable of working the richer spots below high-water mark during calm weather and changing to the gulch during storms. This gulch has been worked for years for gold, and considerable platinum has been wasted which it is now hoped to recover. The stretch of 6 miles or more of beach from Port Orford (Curry County) to Cape Blanco has been worked spasmodically for gold for many years. The sand contains the greatest proportion of platinum to gold known anywhere on the coast line. Frequently the value of the platinum yield exceeds that of the gold. This is due to the fact that Sixes River, which empties in the stretch, drains several old beaches some miles in the interior, which are also being redeveloped at this time. In addition to modern concentrators, cheaper methods of collecting the sand are being added, especially scrapers. At Gold Beach, south of the mouth of Rogue River, a new machine is being tested for saving both gold and platinum, which has been used with reported success on the fine gold in the sands of Snake River, Idaho. It keeps the heavy sand from caking during the concentration by means of a jig motion given to the water from a separate compartment. The method of cleaning up the concentrates is still to be determined. The ocean beach at this point is said to yield 40 cents a yard at the surface, and as high as $2 per yard in the black sand at a depth of 15 feet. Some 39 ounces of platinum, valued at $1,003, came from the black sands of Oregon during the year 1912 incident to mining for gold.

DRY PLACERS.

In the arid regions of the Southwest, notably Arizona, southern California, and adjoining areas in northern Mexico, gold has long been known to occur in variable quantities, to some extent in veins but to much greater extent in weatherworn, concentrated form in dry, loose gravels near the surface and in lime-cemented gravel (*caliche, argo masa*) below. Natural concentration of the gold liberated by breaking down of vein croppings has been effected by the small annual rainfall of the country gathering temporarily in depressed areas and channels and leaving the heavier material in these depressions after it disappears. This rainfall, however, is of insufficient quantity to be depended upon to assist in present economical extraction by hydraulic methods used elsewhere in recovery of placer gold.

The amount of gold taken from dry placers in the Southwest is very small.

In earlier years the Sonora district in Mexico undoubtedly yielded much gold from these dry placers, and it seems probable that further production can be expected from these fields and other deposits in the United States, but much remains to be desired in solving the problem of profitable extraction. Costly and financially unprofitable experiments have been reported in attempts at this kind of gold mining, and intending investors might well consult the small body of literature already available on this subject. Detailed information relative to the geology and occurrence of this dry-gravel gold is still largely lacking. References to brief Survey notes and papers published in the technical press were given in the general gold and silver report of the Survey by the writer for 1911. The following notes have been prepared at the writer's request by his colleagues of the Survey for the present report:

DRY PLACERS IN ARIZONA.

By V. C. Heikes.

In Arizona extensive dry-placer areas occur in the valleys of both Colorado and Gila rivers, on the latter 20 miles above its confluence with the Colorado. In the valley of the Colorado placers are known from the vicinity south of Yuma up the river to above Ehrenberg, La Paz, and in the Plomosa region surrounding Quartzsite. Other regions are situated in southern Yavapai County in the Weaver district, in northern Maricopa County known as San Domingo Wash, at Oracle in Pinal County, at Greaterville and Quijotoa in Pima County, in Teviston district in Cochise County, and 20 miles south of Yucca in Mohave County.

Scattered over Arizona are thousands of acres of gold-bearing material which could produce millions of dollars if the proper facilities were at hand. Some of these arid regions may yet be reached by pipe lines for carrying water, but there are others where the ingenuity of engineers will always be taxed to provide machines and methods of handling the material in the dry way.

Character and method of treatment.—The areas of dry-placer ground are largest in Yuma and Pima counties, Ariz., where much of the richer loose material has been worked by Mexicans or *gambucinos* and by other miners in the usual crude way with the batea and the Mexican dry-washing machine. These crude methods required material of very high grade to make it worth while, and only the best was treated. In most of the dry-placer localities the loose material has been worked over many times until the conglomerate bed or lime-cemented gravel (*caliche, argo masa*) has been exposed. Only the softest spots could be worked by the hand machines by digging out the cement, inclosing it in a rawhide bag, and beating it between bowlders. The coarse gravel is removed and the pulverized cement panned in large wooden bateas. The method of operation is, however, exceedingly slow and laborious, and with the invention of the Mexican "dry washer" more material could be handled, though the preparation of the cement for "washing" was still the same. The gold in the cemented placer-gravels does not occur within the pebbles, bowlders, and rock fragments, but on their surfaces, being practically all included in the calcareous cement which unites them. In other localities, chiefly in Yavapai and northern Maricopa counties, the rainfall is depended upon to provide water enough to work the dry

placer material in rockers. Such ground usually embraces only a small acreage and has been the most productive of any in Arizona.

Value of production of gold from dry placers in Arizona, 1903–1912, by counties.

	Yavapai County (Octave), Weaver district.	Maricopa County, San Domingo district.	Yuma County, Plomosa district.	Yuma County, various districts.	Pima County, Quijotoa district.	Pinal County, Old Hat district.	Pima County, Greaterville district.
1903	.....	.....	.....	.....	$5,400	$416	$1,920
1904	.....	.....	$4,000	.....	6,400	3,229	2,500
1905	$16,273	$700	829	.....	8,992	524	5,003
1906	9,466	300	4,754	$9,645	3,000	280	2,826
1907	11,011	800	3,532	8,471	3,800	310	5,000
1908	6,089	787	2,732	7,013	1,054	543	3,101
1909	6,980	694	2,136	6,212	.....	.....	2,200
1910	5,983	1,038	2,368	6,021	250	.....	2,138
1911	4,803	711	2,491	4,596	.....	1,017	2,067
1912	4,812	543	9,472	10,976	922	789	3,539

The total production of gold from dry placers has been variously estimated. The largest amounts are credited to the Yuma County placers and it seems probable that further production of gold can be expected from some of these placers, but whether at a profit to operators and investors or not will depend on thorough understanding of the conditions and on technical and financial management, not only honest but efficient and economical as well. The early production from many localities is known only by hearsay and the estimate of it rather increases as years go by. It is estimated that between 1860 and 1880 the Yuma County placers produced from $20,000,000 to $42,000,000 in gold. Verification of these figures is lacking and they are probably excessive. Since that time about $224,000 has been produced.

Machinery and equipment.—Various forms of dry-placer mining apparatus[1] are used, of which the first is a batea or wooden pan, which is the most elementary form of separating the values.

In using this the air blast is supplied by the lungs and the implement is manipulated with rotary and other motions, which gather the heavy material toward the center, while distributing the lighter material toward the margin, whence it is blown away. The air blast is varied in force according to the material to be removed, and, toward the last, the residue of valueless material is separated from the gold by clever manipulation and blown out of the batea. * * * More commonly used is the Mexican dry washer, said to have been introduced by Hungarians about 1850, and extensively used in northern Mexico. This consists of a tray about 1½ by 3 feet, with muslin bottom and five cross-riffles resting, at an inclination of about 15°, on a frame, beneath which is a canvas bellows. The latter forces through the muslin an intermittent blast of air, which drives away most of the fine light material. The gravel is fed through a hopper upon the upper end of the tray and is moved slowly down the slope by the jar of the bellows' stroke. As the operation proceeds the gold lodges in the riffles, chiefly behind the two uppermost, and the material of lower specific gravity flows on over the riffles and gradually passes out of the machine at the lower end. * * * The chief advance in the development of the Mexican machine * * * is an air jig, made by Steele, Sutton & Steele, in El Paso. In this the stationary tray is replaced by a revolving table or belt about 3 feet wide with riffles about 8 inches apart, and screened with muslin. This is inclined about 30°, the slope being adjustable. The operation of this machine is identical with that of the Mexican "dry washer," except that the operation is continuous, and as the fine is driven away by the intermittent bellows' blast, which passes through the muslin, the riffled belt raises the concentrate to the top of the machine and, passing over, dumps it into a box at the rear. * * * The Curtiss machine, made in Den-

[1] Merrill, F. J. H., Dry concentration of placer gold: Min. and Sci. Press, July 13, 1912.

ver, Colo., uses a continuous blast of air from a fan. As usually constructed, each unit consists of a troughlike box, semicircular in vertical section and covered by a perforated plate, somewhat less than an inch thick. The perforations are semicircular in cross section and about an inch in diameter. They are partly closed beneath by wire gauze, which allows the air blast to pass but retains the concentrate. The boxes, which are usually set in pairs on a frame, have a gentle inclination and receive lateral agitation from a cam. The pay dirt is fed upon the upper end of the plate and, as it passes down the slope, the fine material is blown away and the concentrate is caught in the holes or recesses which serve as riffles, the tailing escaping at the end. To clean up, the machine is stopped and the plate is rotated on a longitudinal axis, dumping the concentrate into the trough below, from which it is removed. * * * Another type is the Shumway concentrator. * * * This consists of a shallow wooden box covered with thin canvas through which a continuous air blast is forced by a fan. Over the canvas, wire netting of about half-inch mesh is laid. By means of cams the box, which is slightly inclined, is agitated laterally and the dirt fed upon the canvas, at the top of the incline, passes down the slope, leaving the concentrate in the meshes of the wire, while the tailing falls to the ground. To recover the concentrate, the operations of this machine must be suspended and the table tilted for cleaning up. * * * The Jardine concentrator, made in San Francisco, is the result of a diligent effort to construct a durable machine which is continuous in operation and does not stop for cleaning up. The air blast comes from a fan, but is made intermittent by a rotary valve. The shallow box which serves as an air chamber is interrupted across its length by riffles of parallel metal plates with intervening slits which guide the concentrate down into cylinders in which worm conveyors rotate, conducting the gold and heavier materials to a trough at one side. Between the riffles, the surface of the table is formed of a cotton-cloth screen, through which the air blast passes. Lateral agitation is provided and, as the dirt passes down the sloping table, the fine light material is blown away. The concentrate caught by the riffles is delivered into the trough at the side and the tailing passes away at the end of the table. * * * The Stebbins table, made in Los Angeles, in general form and action resembles closely the Wilfley table. The surface and the riffles are formed from sheet metal, the latter being about 1 inch apart. Air is introduced beneath the table in a continuous blast from a fan and reaches the bed of dirt through minute perforations in the metal surface of the table. These perforations, which are as close together as possible, are rectangular and about one-fourth inch long and one-fortieth to one sixty-fourth inch wide. The longer axes of these slits stand at about 45° to the direction of the riffles. The form of the slit gives the air jet an inclination of about 10° above the surface of the table, and the air sheet formed by these jets flows with the dirt in its descent along the slope. * * * The total number of machines devised for this work can probably be reckoned by hundreds. Most of them have been short lived. * * * The concentration, to be successful, must be capable of working effectively on material of all sizes up to one-eighth inch. This mesh has been determined for many localities in Sonoro, Mexico, as one which will allow most of the coarse gold to pass through with the fine. Should there be much coarse gold present in the gravel, the screen must be made proportionately coarser and the concentrator must work on coarser material. Primarily the pay dirt treated must be dry. * * * The cemented gravels are crushed with great efficiency by the Quenner pulverizer, which consists of a revolving trommel or barrel of steel staves with a shaft rotating independently within and carrying chain hammers. The hammers effectively break up the calcareous cement and leave the cobblestones and pebbles with nearly clean surfaces to be ejected at one end of the barrel, while the pulverized cement escapes through the quarter-inch spaces between the staves. Thus in many localities the material subjected to dry concentration for the recovery of the gold is only about one-half of the total mined.

Plomosa district.—The Plomosa mining district,[1] lying east of Colorado River in Yuma County, Ariz., is situated—

in the Posas Valley, a great north and south depression, with the Plomosa Mountains forming the eastern border and northward extension of the Castle Dome Range on the west. Posas Valley trends northward 30 or 40 miles, and is from 10 to 15 miles wide. It slopes to the north and affords a very extensive field. * * * In this valley are situated * * * on its eastern side the Plomosa placer and on the western side an extended deposit of gold-bearing gravel known as the La Cholla, Oro Fino, and Middle Camp. In some localities pits have been sunk to a depth of 20, 30, and 50 feet or more to beds of cement, which are richer than the gravel. Near the moun-

[1] Church, John A., Plomosa mining district—extracts from a professional report dated Mar. 19 1901.

tain the gold is coarser, but the gravel is much less. Miles of the great deposit extending westward from the mountains, and from 3 to 4 miles in width, have been cut into by floods from the mountains, forming deep ravines, and they afford miles of banks 10 to 15 feet high in which the upper layer of gravel is well exposed. From these banks, as far as investigations could be made, samples gave an average return value of 64 cents per cubic yard with gold estimated at $18 per ounce. * * * There were no failures. The results lay between the extremes of 42 cents and $1.04 per cubic yard. To get the limit of the deposit it would be necessary to pursue the tests to points where gold failed. * * * A dry washer was used, winnowing the sand by means of a rotary fan, which blows under a fine screen over which the sand passes in a thin stream. * * * The limit of the gravel actually explored was 2,400 by 1,500 feet and 8 yards deep. * * * Within this area bedrock was not reached at any time * * * Across the valley and about 12 miles from the Plomosa placer is another bed of gravel of similar extent and of high quality. * * * This western mass of gravel is occupied at various places by three camps all rich in gold, and all differing materially in character of gravel. Middle Camp, the most northerly of the three, has granite gravel; Oro Fino, in the center, has much porphyritic slate; and La Cholla, at the south, is mostly composed of quartzite and schist pebbles. * * * At La Cholla * * * which is nearer the mountains, there is a siliceous cement, very rich, but also so very hard that it requires to be broken by powder before going to the dry washer. At Oro Fino the shale bedrock is very near the surface. In Middle Camp there is cement, but of a much softer kind. * * * (Here most of the sampling was performed.) * * * [The camp (?)] occupies the east and west valley crossing the mountain range, a mile wide and 4 or 5 miles long. * * * This is the chosen locality for the individual dry washer, who takes his machine to some point where the bedrock can be reached quickly. It is here that the rich seams of gravel on the bedrock yield from four to ten times the value of the thicker gravels, and in crevices there have been found nuggets worth $10 to $25. La Cholla, south of Middle Camp, lies along the foot of the mountains like Plomosa and is 3 or 4 miles in length. * * * The depth of the gravel is irregular in passing from Middle Camp through Oro Fino to La Cholla. Forty years ago Colorado River was the main gateway, and freight for many years entered that way. The value of these placers was known to the miners who, in that early day, passed over all the region adjoining the Colorado, but the almost total absence of water in the mountains compelled the miners to pack their rich dirt to the river or to distant national tanks to be washed. Oro Fino was the most celebrated camp of that day; there the soft shale bedrock rises to the surface, and when the art of dry washing was learned the rich bedrock was the scene of active work and much of it has been washed and rewashed many times.

Surrounding the post office of Quartzsite, in the Plomosa mining district, and extending in every direction covering an area of about 7,500 acres, is found dry-placer ground with values to an average depth of 15 feet and varying from 5 to 50 feet. The gold content per cubic yard is reported to average in coarse gold from 10 cents to several dollars. Efforts are being made to get a combination of equipment which will successfully work the desert gravels and gold-carrying cement gravels at a minimum cost per yard. At a point south of Quartzsite and 17 miles north of Ehrenberg, on Colorado River, a reduction plant capable of handling 2,000 cubic yards of gravel every 24 hours is reported under construction. The machinery consists of a Barnett dredger, a Quenner disintegrating machine, and a Stebbins concentrator.

La Paz district.—The placer deposits near the Dome Rock Mountains, in Yuma County, were among the earliest discoveries in central western Arizona. This region, embracing the La Paz district, is described in a Survey report[1] giving a brief history of the region, which is also mentioned in other early reports.[2]

In the La Paz district the dry placers lie in Ferra, Garcia, Ravenna, and Goodman gulches, about 9 miles northeast of Ehrenberg. The gravel is more or less enriched throughout, but the greater values

[1] Bancroft, Howland, Bull. U. S. Geol. Survey No. 451, 1911, p. 85.
[2] Raymond, R. W., Mining statistics west of the Rocky Mountains, vol. 1872, p. 336, and vol. 1874, p. 344.

are found on bedrock. Bench gravels form the largest part of the deposits, which are reported 50 feet deep and to average $1.50 per cubic yard in coarse gold. The largest nugget found in this region was valued at $1,150 and assayed about 0.870 in fineness. One of the companies has a reservoir and preparations are under way for a hydraulic plant which will be supplied with water from Colorado River. A Newkirk hydraulic elevator will raise the gravel to sluice boxes.

Weaver district.—For over 35 years the dry washes, gulches, and mesas of the Weaver district in the southern part of Yavapai County have been worked after each rainfall for the gold which has been caught in depressed areas and channels. The placer ground containing values extends from 1 to 10 feet in depth over an area of 5 by 8 miles. Stream gravel sand and mesa soils carry the gold, which, in the gulches, is very coarse, while on the mesas it is flaky and fine. The largest nugget found was reported to be worth $400. All of the gold has a fineness of 0.910. During 1912 about 30 placer miners, both Mexicans and Americans, were working with dry washers, rockers, or, when water permitted, by sluicing, and produced nearly $5,000 in gold.

San Domingo district.—About 45 miles northwest of Phoenix is San Domingo Wash, in northern Maricopa County, where dry-placer ground is situated, covering an area 1,200 feet wide by 2½ miles long, with an average depth of 10 feet, and containing a reported average of about 40 cents per cubic yard. The surface is scarred by frequent watercourses down which the water runs in torrents after a heavy rain. It is proposed to work this placer by taking water from a reservoir built in "Rogers Wash," or by building a dam in Hassayampa River to catch the underground flow and to pipe the water to the placers. Gold has been produced from this locality for many years by miners operating dry-washing machines.

Teviston district.—During the wet season dry-placer ground in the Teviston district, Cochise County, yields a small quantity of gold yearly. About 300 acres have been reported valuable to a depth of from 3 to 10 feet, the latter being the greatest depth prospected. Bedrock is from 50 to 75 feet in depth. Most of the gold is coarse, and the ground by tests has yielded from 3 cents to $28 per cubic yard. The largest nugget found was valued at $375. Some cement or caliche has been found in prospecting the ground, but values have been found in the gravel beneath.

Old Hat district.—An area of 25,000 acres in the Old Hat district,[1] Pinal County, covering nearly the whole of Tp. 10 S., R. 14 E., Gila and Salt River meridian, distance 4 to 10 miles south from Oracle post office and 16 to 29 miles north from Tucson, is found containing valuable dry placer gravel, which has apparently been deposited at intervals by floods from the Santa Catalina Mountains so as to form a deposit of nearly equal value from surface to bedrock, there being no pronounced accumulation of heavy gold at bedrock except in the stream, Canada del Oro Creek, which passes through the region. The bed of dry gravel is from 6 feet deep at the creek side to 252 feet at the summit, with an average thickness of about 150 feet. The deposit is in general a loose gravel, uncemented. There are, however, alternating strata of deep red, clayey material. These strata are of nearly

[1] Burgess, Capt. J. D., personal letters.

uniform thickness of 3 to 4 inches and probably were formerly surfaces existing between floods, each being covered by a later flow of gravel from rainfall eroding veins farther up the mountain. Shafts sunk on the hillsides from 27 to 50 feet in depth show values from 10 to 42 cents per cubic yard. The average is difficult to determine, as the gold is not equally distributed. All the gold found is in well-rounded nuggets ranging from 50 cents to $5 in value. There is a tradition of a lump weighing 16 pounds, with probably 40 per cent of quartz, whose discoverers were found murdered in their camp 16 miles north of Tucson. The nugget had disappeared. In fineness the gold averages about 0.905. Generally the placer material is dug, screened, and hauled to the creek and there worked by rockers or sluiced when there is enough water. Many dry washers have been tried, but most of the gold lies in the red, clayey seams which apparently acted as "bed rock" for each period of deposition. Pulverizing this adherent material gives good results with the common bellows type of "dry wash." A boiler and pump were once used to throw water against the creek bank, but the water at that time proved insufficient for extensive operations.

Quijotoa district.—The Quijotoa district, in Pima County, lies west of Tucson, extending north and south some distance on both sides of the Mexican line. This area has been worked in places for free gold by Indians and Mexicans for hundreds of years. The gold is found from the surface down into a strata of cement gravel or caliche. The caliche carries more gold than the dirt above it. The Indians work the dirt above it, and then the softer places in it by beating it in a rawhide bag, finally separating the gold with hand machines, which are very crude affairs. The Quenner machine was tried in this field, but conditions were not similar to those where the machine has been the most successful. Therefore, the production of gold is very much the same as formerly, only a few hundred dollars a year, which is traded for supplies by the Indians and Mexicans working the placers.

Greaterville district.—At Greaterville, in Pima County, about 9 square miles of dry-placer gravel have been operated intermittently for many years. A description of the region is given in a paper [1] published by the Survey.

The pay streaks of gravel and clay averaging about 3 feet in thickness are overlain to some extent with 12 feet of valueless surface material. Bedrock is found from 40 feet in depth to within 6 inches of the surface. Tests have proved the ground to yield an average of 35 cents per yard in flake, fine, and coarse gold. The fineness of the gold ranges from 0.800 to 0.850. Production is greatest when the gold can be recovered by wet washing, although dry washing on a very small scale by *gambucinos* is more prevalent.

DRY PLACERS IN NEVADA.

By V. C. Heikes.

Nevada has dry placers near Battle Mountain in Lander County, in Lynn district in Eureka County, at Round Mountain and Manhattan in Nye County, and in Paradise district in Humboldt County.

Battle Mountain district.—In the Battle Mountain district of

[1] Hill, J. M., Notes on placer deposits of Greaterville, Ariz.: Bull. U. S. Geol. Survey No. 430, 1910, pp. 11–22.

Lander County a small area of dry placer ground has been worked intermittently. The richest ground lies at the mouth of Copper Canyon near Galena, and in Black Canyon at Bannock. Much of the gold is coarse and ranges in fineness from 0.830 to 0.871. The best results have been found at the edge of the foothills. Dry washers and rockers have been used, but for the latter, at one camp, water is hauled 5 miles. The pay streaks are from 2 to 18 feet in depth to bedrock with values from the surface. Tests have shown an average of $1.34 per cubic yard, and the lowest value was $0.59 and the highest $57.22. The largest gold nugget found on one of the Bannock claims weighed 3.51 ounces.

Lynn district.—Dry washing in the Lynn district of Eureka County has been productive of considerable gold during a number of years. The placer gravels are worked in the spring months with rockers as long as the snow water lasts and after July by the usual dry-washing machine. There are about 7 miles of ravines, gulches, and canyons, which average 25 feet wide and from surface to a depth of about 10 feet in center of the depressions. All of the material is probably derived by erosion of the area of minute auriferous quartz gash veins. Average tests have yielded $4.50 per cubic yard, and the lowest yield was $1 and the highest $51. The gold is very fine and is in all shapes and forms, showing but little erosion. The largest nugget, valued at $21, was found in Lynn Gulch by Ernest Kappler. In fineness the gold ranges from 0.928 to 0.934. The principal claims are the Gold Dollar, Kappler's Hilltop, Pedro's Bulldog, Compromise, Five Lone Star, Jingo, and Bunker Hill groups. About $40,000 in gold has been produced since operations began.

Paradise district.—Dry placers were worked in 1912 in the Paradise mining district, known as Dutch Flat, in Humboldt County, 18 miles east of Winnemucca. In extent these gravels cover 200 acres, or 300 to 2,000 feet in width to 8,000 feet in length. The pay streaks, which are from 6 inches to 3½ feet, are covered with an overburden of from 8 to 20 feet. Tests have shown an average of 60 cents in flour gold, rarely coarse, and about 0.940 fine. Experiments are being made with wet concentration to save the values.

About 20 miles south of Sulphur, on the Western Pacific Railway, at Rabbit Hole Well, in Humboldt County, a dry placer has been operated by the use of water pumped from a 50-foot well. The gravel was worked from 2 to 4 feet below the surface and conveyed to the sluice box, 12 inches wide, 8 inches deep, and about 25 feet long, by scrapers. All the operations were confined to the surface, although black sand and some fine colors were taken from the bottom of the well 50 feet below the surface. As far as tests were made, the best values were found in the bottom and on the sides of the small ravines, also over the sidehills for a distance of 5 to 8 miles to the north and west of the Rabbit Hole Well. About $400 was produced in 1912.

DRY PLACERS IN NEW MEXICO.

By V. C. Heikes.

New Mexico has dry placers in the Placitas-Tejon region of Sandoval County and in the Las Animas district of Sierra County.

Placitas district.—Placer mining has been carried on in the Placitas-Tejon region of Sandoval County, but on account of the lack of water

it has not been a paying undertaking. By dry washers, however, men have been able to make $3 a day. The gold here is in a gravel conglomerate at the north terminus of the San Dias.

Las Animas.—In the Las Animas district, Sierra County, dry-wash and gulch mining have been productive about 6 miles northeast of Hillsboro, the nearest post office. The dry placers cover several square miles from one-half inch to several feet in depth. Gold is practically all worked on false bedrock. Nothing is known of the original bedrock. Fake tests have averaged $1.25 per cubic yard, but average working tests from 22 to 25 cents. The largest nugget found was valued at $85, and the fineness of the gold ranged from 0.945 to 0.956. This property was worked about six months in 1912 with the use of the Quenner trommel mill and Hilltscher Bros. dry concentrator. The machinery was operated by gas-engine power. These placers, of which the Luxemburg claims are the most important, contain a piece of undisturbed cement gravel left standing of about 20 acres, which lies at the head of all the placer field. Gold is found on a false bedrock and as a rule is very coarse. The cement is worked sometimes to the depth of 8 feet to bedrock and averages in thickness about 5 feet. The average value in gold disseminated through the cement is about $2 per yard. Bedrock is soft, but the cement above it, which varies from a few feet to 30 feet, is so hard that every foot of the pay streak has to be blasted with powder. The Quenner machine handles 5 tons an hour and throws out the largest part of the rock and bowlders. The discharge is run over a concentrator made of iron, which catches all of the coarse gold that will not pass the staves of the Quenner trommel. The fine passes over four dry tables built on the plan of a simple bellows dry washer. The Quenner machine is driven by an 8 horsepower gas engine and the tables and conveyor by a 5 horsepower engine. Extraction is reported to be over 90 per cent when the material worked is perfectly dry. A paper[1] prepared by members of the Survey gives descriptions of the placer regions of New Mexico.

DRY PLACERS IN CALIFORNIA.

By Charles G. Yale.

An attempt was made during 1912 to ascertain the condition of the industry of dry washing for gold in California, particularly in the semiarid and desert regions, but it was not as successful as hoped for. Most of the men working the dry placers are nomadic in their pursuits and only go to the camps during the season when the weather is not too hot. These localities, too, are usually isolated, at points where there are no towns or communities.

There is some dry washing going on in the Summit and Goler districts, near Randsburg, Kern County, but those who control the properties are reticent as to results. Work of this kind is also being done about 12 miles southeast of Ricardo, in the same county, in Last Chance and Black Mountain camps, but no output has been reported there lately. Christmas Camp, 24 miles north of Garden Station, is being worked by dry washing. At Coolgardie Camp, 20 miles north of Barstow, some gold from ancient river bed gravel was obtained

[1] Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 74–76.

by dry washing. There is a dry gold washing company which recently started operations 2 miles south of Randsburg, and which, it is reported, is meeting with some success. Some desultory work is being done in dry washing at a few places along Colorado River in Riverside and San Bernardino counties. The scattered claims are only worked occasionally. From the Bonanza and Deep Diggings mines, in Red Rock district, Kern County, some gold production is reported. The miners can not figure on any average yield per cubic yard, for the gold is only found in spots, and these are growing scarcer every day. Here, as at other places, the gravel wash or pay dirt lies at varying depths of 2 to 20 feet on the bedrock, and only the dirt close to the bedrock has gold enough to pay for working. Even then, it is in spots only.

There were formerly several makers of dry-washing machines in Los Angeles, but as far as known there is only one now and no information could be elicited from him. He is making what he calls a "three-man machine," weighing about 50 pounds, and costing $50. Most of the men working at this business make their own dry-washing machines. They are all "bellows" machines, in which a pulsating pressure of air is forced through canvas stretched on wire screen, blowing off the fine material on the canvas and leaving the gold and black sand to be subsequently panned. Wire screens are first used to take out the coarser gravel and refuse before the partly concentrated material is placed on the canvas shaking table. The whole system is one of concentration by air.

The total output of these dry placers amounts to but a few thousand dollars annually in California, because the most of the operations are carried on by individuals in a small way.

DRY AND SILICEOUS ORES.

In 1912, dry and siliceous ores, including true gold ores and precious metal bearing ores not classed as copper, lead, or zinc ores, produced $62,119,916 in gold, against $66,369,199 in 1911. States producing over $1,000,000 in gold from these ores in 1912 ranked as follows: Colorado, Nevada, California, South Dakota, Alaska, Arizona, Montana, and Utah.

Increased output from this source was recorded for 1912 from Alaska, Arizona, California, and South Dakota, and decreases from the other States mentioned.

The siliceous ores are in part free-milling (amalgamating), as in Alaska, California, and Oregon; in part both amalgamating and concentrating, as in many States; in smaller part simply concentrating ores, as in parts of Colorado and Arizona; or smelting ores. Tailings both from old dumps and from present milling are largely reworked by concentration and subsequent cyanidation. The all-sliming cyanidation method is also of increasing importance, and crushing is largely by tube mills as well as by stamp and gyratory mills.

The loss in tailings from gold mills is being constantly cut down and the most serious present loss is in tailings from concentrating plants. The chlorination process is of decreasing relative importance. Smelting is mainly of concentrates and of siliceous and pyritic ores which are also valuable as fluxes. Exact figures of relative output by methods will appear in detail by States in another table.

COPPER ORES.

The production of gold from copper ores was $5,424,047 in 1912, against $5,450,079 in 1911. Increases in gold output from these ores were noted in 1912 for Alaska, Arizona, Montana, Nevada, and New Mexico, and decreases for California and Utah, caused in the former State mainly by smelter litigation, in the latter by labor troubles. The States producing over $1,000,000 in gold from copper ores in 1912 were Utah and Arizona, followed by those with less than $1,000,000, Montana, Nevada, and California, all in the order named, which was the same ranking as in 1911. The gold is recovered from these ores by electrolytic refining of blister copper obtained in smelting crude ores and concentrates.

LEAD ORES.

The output of gold from lead ores in 1912 was $1,348,087, against $1,201,606 from this source in 1911. The Utah lead ores ranked first in yield of gold from this source, followed by those of Colorado, as in 1911. The remainder of the gold from lead ores is chiefly from Nevada, Arizona, Idaho, and Montana, in the order named. Increases for 1912 are noted for Colorado, Idaho, and Nevada, and decreases from the other important States.

LEAD-ZINC, ZINC, AND MIXED ORES.

Production of gold from lead-zinc ores was $258,177 in 1912, against $357,455 in 1911. The output was mainly from Colorado and Utah. From zinc ores the gold production was $100,898 in 1912, against $43,624 in 1911, chiefly from Arizona and Montana. From mixed copper-lead and copper-lead-zinc ores the gold output was $47,538 in 1912, against $23,221, chiefly from Colorado, Utah, and Montana.

DISTRIBUTION OF SILVER PRODUCTION OF 1912, BY SOURCES.

The mine production of silver from dry or siliceous ores, copper ores, and lead ores combined in 1912 was 93.47 per cent of the total output, against 94.21 per cent in 1911. The production from dry or siliceous ores decreased from 41.25 per cent of the total silver output in 1911 to 39.88 per cent in 1912, and the output from lead ores decreased from 25.53 to 25.20 per cent, but the output from copper ores increased from 27.43 to 28.39 per cent. The yield from lead-zinc ores also increased from 4.01 to 4.26 per cent, and that from mixed copper-lead and copper-lead-zinc ores from 0.47 to 1.01 per cent. The small outputs from zinc ores and from placers showed little change.

The following table shows the source of silver production of the United States by classes of ores, by States:

Source of silver in 1912 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper lead-zinc ores.	Lead-zinc ores.	Total.
Alabama		168						168
Alaska	102,897	35,696	376,593					515,186
Arizona	388	373,255	2,378,593	599,110	87,461	18,680	32,900	3,490,387
California	35,652	409,873	792,445	35,492	26,674			1,300,136
Colorado	5,106	5,397,439	224,327	1,470,930	130,392	389,449	594,427	8,212,070
Georgia	23	54						77
Idaho	7,278	232,583	451,918	7,085,596	597	3,487	513,286	8,294,745
Illinois				4,731				4,731
Maryland and Pennsylvania			502					502
Michigan			528,453					528,453
Missouri				35,438				35,438
Montana	5,852	1,318,505	10,655,055	266,014	402,679	80,688	2,845	12,731,638
Nevada	4,474	13,135,677	173,545	841,733	510	4,327	208,797	14,369,063
New Mexico	140	1,141,786	290,568	68,936	1,167	3,874	30,230	1,536,701
North Carolina	35	1,902	523				2,394	4,854
Oregon	1,941	44,018	10,555	567				57,081
South Carolina		47						47
South Dakota	65	201,14		5,246				206,460
Tennessee			89,893					89,893
Texas		404,180	10	1,480			397	406,067
Utah	46	3,486,562	2,542,381	6,212,219	14,941	154,091	1,425,663	13,835,903
Virginia			982					982
Washington	56	180,394	228,203	4,885				413,538
Wyoming	2	148	115					265
Total, 1912	163,955	26,363,436	18,744,661	16,632,377	664,421	654,596	2,810,939	66,034,385
Value	$100,832	$16,213,513	$11,527,966	$10,228,912	$408,619	$402,577	$1,728,728	$40,611,147
Percentage of total	0.25	39.88	28.39	25.20	1.01	1.01	4.26	100.00
Total, 1911	170,084	25,205,749	16,759,638	15,596,638	630,573	285,006	2,460,152	61,107,840
Value	$90,144	$13,359,047	$8,882,608	$8,266,218	$333,604	$151,053	$1,303,881	$32,387,155
Percentage of total	0.28	41.25	27.43	25.53	1.03	0.47	4.01	100.00

[a] Philippines and Porto Rico not included in this table.

PLACERS.

The output of silver from placers, mainly in Alaska and California, was 163,955 fine ounces in 1912, against 170,084 ounces in 1911. The recovery is by refining the placer gold.

DRY AND SILICEOUS ORES.

The yield of silver from dry and siliceous ores in 1912 was 26,363,436 fine ounces against 25,205,749 ounces in 1911. The most notable gains were in Colorado, from 5,096,026 ounces in 1911 to 5,397,439 ounces in 1912; in Nevada, from 12,830,194 to 13,135,677 ounces; and in Utah, from 2,569,157 to 3,486,562 ounces. In Montana the production fell off from 1,613,253 to 1,318,505 ounces; in New Mexico, from 1,183,265 to 1,141,786 ounces; and in Texas, from 422,870 to 404,180 ounces.

In order of production from this source the five leading States ranked as follows in 1911 and 1912: Nevada, Colorado, Utah, Montana, and New Mexico.

With a few notable exceptions, where there are mines producing true silver ores, as in San Bernardino County, Cal., the dry or siliceous ores are gold-silver or silver-gold ores (the latter notable at

Tonopah, Nev.). The rich surface outcrops, mainly of chloride silver ores, found and worked in the arid West in the early days, have long since been exhausted in explored territory, and there appears little likelihood of further extensive supply from new finds. Deeper silver deposits may of course at any time be found. With high prices of silver, old silver producers closed down 20 years ago in the West may be reopened and prove productive again.

The Nevada output is mainly from the Tonopah district, and the Colorado production is chiefly from the Leadville, Upper San Miguel, and Sneffels districts. As shown later, a large part of the output of silver from the gold-silver siliceous ores is with the gold by amalgamation and cyanidation and the metals are separated in refining the gold. The remainder is produced by smelting the richer ores, and the silver is then recovered in the refining of the copper or lead bullion.

COPPER ORES.

The production of silver from copper ores was 18,744,661 fine ounces in 1912, against 16,759,638 ounces in 1911, corresponding to a similar increase in 1911.

The silver production from copper ores is from electrolytic refining of Lake and blister copper produced by smelting. The copper ores are mainly sulphides (except the Lake ores of Michigan, which are native metal in amygdaloid or conglomerate matrix), and a greater tonnage contains chalcocite, chiefly secondary, than primary chalcopyrite, or cupriferous pyrite. The great disseminated copper deposits of Utah, Arizona, Nevada, and New Mexico are of constantly increasing importance. The silver content per ton of the extensive Chino copper deposits of Santa Rita, in New Mexico, however, is notably low. Copper ores are mainly concentrated before smelting. Oxidized copper ores of decreasing relative importance, which are sought for largely as fluxing ores and commonly smelted crude, still come from the Bisbee and Tintic districts.

In output of silver from copper ores Montana led, as in 1911, with 10,655,055 ounces, against 9,597,752 ounces in 1911 and 9,153,590 ounces in 1910; Utah followed with 2,542,381 ounces in 1912, against 2,377,946 ounces in 1911; and Arizona ranked third, with 2,378,593 ounces, against 2,136,121 ounces in 1911. As seen, all of these States showed increased silver output from copper ores. The output from this source has fallen off in recent years in California and Colorado. In Idaho, Nevada, Michigan, and New Mexico, increased yields were recorded for 1912. The production from Montana is mainly from Butte, that of Utah from Tintic and Bingham, that of California from Shasta County, and that of Arizona from Bisbee and Jerome. Of these districts Bisbee alone represents the disseminated type, and output from these ores is still chiefly from deep lodes.

LEAD ORES.

The silver production from argentiferous lead ores in 1912 was 16,632,377 fine ounces, against 15,596,638 ounces in 1911. The output from Idaho increased from 7,059,990 fine ounces in 1911 (an

increase over the output of 1910) to 7,085,596 ounces in 1912, the production from Utah increased from 6,083,877 to 6,212,219 ounces, and that from Colorado from 1,265,594 to 1,470,930 ounces. Fourth in rank was Nevada, with an increase to 841,733 ounces in 1912 from 186,485 ounces in 1911, and fifth was Arizona with a decrease to 599,110 from 635,363 ounces. The output in Idaho has been mainly from the Cœur d'Alene, that in Utah from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. Although much of this silver production is from argentiferous galena, oxidized silver ores are still mined at Tintic, Aspen, and a few other camps.

ZINC, LEAD-ZINC, AND MIXED ORES.

Argentiferous zinc ores supplied 664,421 fine ounces of silver in 1912, against 630,573 ounces in 1911, the output and increase being mainly from Montana and Colorado, where the zinc-mining industry has been making rapid strides, especially at Butte.

Lead-zinc ores furnished 2,810,939 fine ounces of silver in 1912, against 2,460,152 ounces in 1911. The output and increase are mainly from Utah, which produced 1,425,663 ounces from this source in 1912 against 1,358,311 ounces in 1911, although Idaho and Colorado produced respectively 513,286 and 594,427 ounces in 1912, against 510,667 and 476,049 ounces in 1911.

Copper-lead and copper-lead-zinc ores in 1912 yielded 654,596 ounces of silver, against 285,006 ounces in 1911. The production was mainly from Colorado and Utah (where there were large increases in 1912), and from Montana, where there was decreased output.

DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER, BY METHODS OF TREATMENT.

In the Survey report on gold and silver for 1910 figures were first published showing the distribution of output by methods of treatment.

In the following table a summary is given of the distribution of the gold and silver production of the United States in 1912, showing—

1. Total crude ore, tailings, and slags sold or treated in 1912.
2. Crude ore treated in gold and silver mills.
3. Crude ore concentrated, with resulting concentrates.
4. Crude ore shipped to smelters.
5. Old tailings and slags treated.

The last four include recoverable gold and silver content in fine ounces.

Distribution of production of gold and silver in 1912, by methods of treatment, by States.[a]

State or Territory.	Total quantity of ore, tailings, and slag treated or sold in 1912.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates produced.		
		Quantity.	Gold in bullion.	Silver in bullion.	Quantity.	Quantity.	Gold.	Silver.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska[b]	1,855,266	1,761,799	141,470	21,249	.....	33,986	100,417	14,447
Arizona	6,840,082	198,262	102,245	45,660	4,327,705	411,627	10,276	387,159
California	2,641,497	2,077,300	412,456	247,520	.....	38,373	89,258	59,786
Colorado	2,576,626	1,435,837	551,874	366,084	523,063	224,722	133,829	2,415,514
Idaho	2,266,334	82,568	27,016	201,383	1,985,527	232,347	4,004	5,402,543
Montana	5,552,164	205,409	50,284	68,443	4,497,240	1,534,522	32,264	8,597,953
Nevada	4,763,965	1,309,339	533,612	10,002,279	3,010,976	353,563	63,344	2,301,694
New Mexico	1,352,286	106,208	20,342	842,018	1,142,002	81,811	7,191	290,081
Oregon	90,945	47,603	10,768	2,806	10,130	2,818	9,828	37,434
South Dakota	1,901,726	1,893,836	374,171	179,335	.....	.....	.....	.....
Texas	21,108	20,728	.....	399,972	.....	76	2	4,208
Utah	7,770,270	171,117	21,289	64,468	6,477,567	381,358	44,055	2,785,154
Washington	94,981	21,312	7,774	31,791	7,680	584	9	23,360
Wyoming	2,439	2,266	657	110	.....	.....	.....	.....
Eastern or Appalachian States	865,117	33,751	8,993	2,161	225,415	7,868	503	2,906
Total	38,594,806	9,367,335	2,262,951	12,475,279	22,207,305	4,303,655	494,980	22,322,239
Total, 1911	32,928,522	9,325,090	2,440,339	9,662,545	17,602,315	2,773,870	484,971	20,794,441

State or Territory.	Crude ore to smelter.			Old tailings and slags treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska[b]	93,467	7,532	376,593	.....	.....	.....
Arizona	2,140,008	67,087	2,982,049	174,107	307	75,131
California	456,735	28,664	955,067	107,462	5,028	2,111
Colorado	617,726	193,013	5,425,366	(c)	.....	.....
Idaho	193,828	5,144	2,679,943	4,411	78	3,598
Montana	839,383	53,660	4,039,623	10,132	152	19,767
Nevada	376,800	36,996	1,546,220	66,850	5,784	514,396
New Mexico	104,076	9,596	404,462	.....	.....	.....
Oregon	4,762	4,990	14,581	28,450	2,517	319
South Dakota	7,890	6,910	27,060	.....	.....	.....
Texas	380	1	1,887	.....	.....	.....
Utah	1,036,268	138,994	10,826,359	85,318	1,748	159,876
Washington	65,989	24,930	358,331	.....	.....	.....
Wyoming	173	382	153	.....	.....	.....
Eastern or Appalachian States	605,951	492	91,398	.....	.....	.....
Total	6,543,436	578,391	29,729,092	476,730	15,614	775,198
Total, 1911	5,588,771	611,344	29,831,111	412,346	16,259	99,475

[a] Exclusive of small quantity of silver from copper ores in Michigan and lead ores in Missouri and Illinois.
[b] Small quantity of gold and silver included from copper concentrates included under crude ore smelted.
[c] Included under ore sent to gold and silver mills.

The first item consists of all classes of ores, tailings, and slag producing gold and silver in the United States in 1912. The grand total shows that this tonnage increased from 30,287,175 short tons in 1910 to 32,928,522 tons in 1911 and to 38,594,806 tons in 1912. This takes no account of placer gravel but represents product of mines producing ore only. The most important increases in 1912 were in Alaska, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, and Utah, and decreased outputs are noted from California and South Dakota.

In reference to the second item, many gold and silver mills employ concentrating apparatus, and the concentrates resulting are combined with those from straight concentrating mills in the column of the table "concentrates produced." The gold and silver recovery under this item is mainly by amalgamation and cyanidation, as is shown in detail in the last table of this report. The total quantity of

crude ore treated in gold and silver mills of the United States increased from 8,528,596 short tons in 1910 to 9,325,090 tons in 1911 and to 9,367,335 tons in 1912. Increases in tonnage milled are noted particularly for Alaska, Arizona, Colorado, Nevada, Washington, and Wyoming, and decreases for California, Idaho, Montana, New Mexico, Oregon, South Dakota, Texas, Utah, and the southern Appalachians. The total quantity of gold recovered by mills in 1912 was 2,262,951 fine ounces (valued at $46,781,349), against 2,440,339 ounces in 1911 and 2,366,322 ounces in 1910. There was increased output from Alaska, Arizona, California, Oregon, South Dakota, Washington, and the southern Appalachians, and decreased production from Colorado, Idaho, Montana, Nevada, New Mexico, and Utah. The total silver recovery in mills was 12,475,279 fine ounces in 1912, against 9,662,545 ounces in 1911 and 8,245,851 ounces in 1910—a marked trend upward. There was increased silver production in Alaska, California, Nevada (notably, as in 1911, also), New Mexico, Oregon, and South Dakota, and decreased output from Arizona, Colorado, Idaho, Montana, Texas, and Utah.

Under the third item is given the quantity of ore treated for concentration only, including the large quantities of copper, lead, zinc, and mixed ores, whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper, lead, and zinc. Examples are the copper ores of the disseminated deposits of Bingham, Utah, the ores of Butte, Mont., the lead ores of the Cœur d'Alene, Idaho, and some of the lead-zinc and mixed ores of Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content, however, as already stated, represent not only the concentrates from these straight concentrating mills but also those from gold and silver mills. The concentrates are mainly smelted, as stated, but are in some cases treated in gold and silver mills by the processes named. Comparison with corresponding figures published by the Survey for 1911 shows that the total tonnage treated in straight concentrating mills (for concentration only) increased from 15,407,515 tons in 1910 to 17,602,315 tons in 1911 and to 22,207,305 tons in 1912, the greater part of the increase being credited to Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, and Utah. The total gold and silver bearing concentrates produced in all classes of mills increased from 2,597,992 tons in 1910 to 2,773,870 tons in 1911 and to 4,303,655 tons in 1912, the increases being mainly in Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, and Utah. The total recoverable gold content of all concentrates aggregated 494,980 fine ounces valued at $10,232,144 in 1912, against 484,971 ounces in 1911 and 475,452 ounces in 1910, the increases being mainly in Alaska, Colorado, Montana, and Oregon, and the decreases in California, Nevada, and Utah. The recoverable silver in concentrates produced increased from 19,949,379 fine ounces in 1910 to 20,794,441 ounces in 1911 and to 22,322,239 ounces in 1912. The increased output was most notable in Alaska, California, Colorado, Idaho, Montana, Oregon, Utah, and Washington, and the decreases were mainly in Arizona, Nevada, and New Mexico.

The fourth item covers quantity and recoverable precious-metal content of crude ore shipped direct to smelters from the mines, and in general includes the richer gold, silver, copper, lead, and zinc ores from which the gold and silver are eventually recovered by refining

the copper or lead bullion that collects the precious metals in the smelting. The total quantity shipped of this class of ore decreased from 6,016,425 short tons in 1910 to 5,588,771 tons in 1911, but increased to 6,543,436 tons in 1912. The increases for 1912 were mainly in Alaska, Arizona, Colorado, Idaho, Montana, Nevada, and New Mexico; and the decreases were chiefly in California and Utah. The tonnages are notably large in Arizona and Utah and the bulk of the precious metal bearing ores of the Eastern States are smelted crude. The total gold output from crude ores smelted decreased from 623,272 fine ounces in 1910 to 611,344 ounces in 1911 and to 578,391 ounces, valued at $11,956,403, in 1912, the decreases being chiefly in California, Idaho, Montana, Nevada, Utah, and Washington, and the increases in Alaska, Arizona, Colorado, New Mexico, Utah, and Washington. The total recoverable silver output in crude ores shipped to smelters increased from 28,487,837 fine ounces in 1910 to 29,831,111 ounces in 1911 and decreased to 29,729,092 ounces in 1912. The increases in 1912 were chiefly in Alaska, Arizona, Colorado, New Mexico, Utah, and Washington, and the decreases in California, Idaho, Montana, Nevada, Oregon, and South Dakota.

Under the fifth item is given the quantity of old materials, principally slags and tailings, re-treated, and their recoverable contents. These are largely smelted, sometimes mainly for their fluxing values, but increasing quantities of old tailings are now concentrated and cyanided, as in the case of Cripple Creek. The Colorado tailings treated are included in the first column of the table with crude ore. The concentrates produced from old tailings, and their gold and silver content, are included under "Concentrates produced." Comparison of the figures for 1911 and 1912 shows that the total quantity of this old material treated (excluding that in Colorado) increased from 412,346 short tons in 1911 to 476,730 tons in 1912, but that the recovered gold content decreased from 16,259 to 15,614 fine ounces and that the silver recovery increased from 99,475 to 775,198 fine ounces.

From this table the output of ore from the Central States, producing insignificant quantities of silver and no gold, has been omitted. The output of zinc ore from the Eastern States is also omitted, as this zinc ore is reported to produce no silver or gold.

The following table shows in summary the percentage of total output, by processes, of gold and silver in the United States in 1911 and 1912:

Percentage of output of gold and silver by processes in the United States in 1911 and 1912.

Production by—	Percentage of total output.			
	Gold.		Silver.	
	1911	1912	1911	1912
Placers	24.2	24.8	0.3	0.2
Gold and silver mills:				
By amalgamation	23.9	22.3	1.5	1.2
By cyanidation	26.1	30.9	14.2	17.8
By chlorination	3.8	0.4	.....	.....
Total milling	53.8	53.6	15.7	19.0
Smelting [a]	22.0	21.6	84.0	80.8
Total	100.0	100.0	100.0	100.0

[a] Both crude ore and concentrates.

The mills contributed over half the gold output in 1911 and 1912 and increased the relative output of silver from 15.7 per cent of the total in 1911 to 19 per cent in 1912. The placers, the amalgamation and the cyanidation processes, and the smelters supplied practically all the gold production in nearly equal parts, the recovery of gold by the chlorination process having declined from 3.8 per cent of the total output of gold in 1911 to 0.4 per cent in 1912. The placers and amalgamation processes contribute very small percentages of the total silver production. The bulk of the output remains from the smelters treating crude ore, concentrates, and other material, the percentage of total output of silver from this source having declined, however, from 84 per cent in 1911 to 80.8 per cent in 1912. This decline is explained by the corresponding rise in relative recovery of silver by cyanidation, from 15.7 per cent of the total output in 1911 to 19 per cent in 1912.

The following table shows in greater detail the tonnage treated and output of precious metals by gold and silver mills, by States, in 1912:

Quantity of ore treated at gold and silver mills in 1912, giving recoveries by amalgamation and cyanidation and percentage of each to gold and silver recovered from all sources.

State.	Ore and tailings treated.	Bullion recovered.				Percentage of gold and silver from all sources.			
		Amalgamation.		Cyanidation.		Amalgamation.		Cyanidation.	
		Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*				
Alaska	1,761,799	141,470	21,249	97,369	10,929	17.0	4.1	11.7	2.1
Arizona	198,262	11,433	2,922	90,812	42,738	6.3	0.1	49.9	1.2
California[a]	2,184,762	391,421	213,099	51,423	72,715	41.0	16.4	5.4	5.6
Colorado	1,638,400	93,283	10,622	[b]458,591	355,462	10.4	0.1	50.0	4.3
Idaho	82,568	12,852	6,107	14,164	195,276	19.2	0.1	21.2	2.4
Montana	205,409	9,327	7,242	40,057	61,201	5.3	0.1	23.4	0.5
Nevada	1,309,339	88,979	60,403	444,633	9,941,876	14.4	0.4	68.3	69.2
New Mexico	106,208	1,781	443	18,561	841,575	4.7	0.03	48.9	54.7
Oregon	47,603	7,953	2,418	2,525	389	21.4	4.2	6.8	0.7
South Dakota	1,893,836	241,502	70,129	132,669	109,206	63.3	33.9	34.7	64.3
Texas[c]	20,728	.....	399,972	.....	.....	.....	98.5	.....	.....
Utah	171,117	141	46	21,148	64,422	0.07	.....	10.2	0.47
Washington	21,312	1,936	869	5,891	30,934	5.90	17.7	0.2	7.5
Wyoming	2,266	604	98			56.1	37.0	4.9	4.5
Appalachian States.	33,751	788	136	7,783	2,007	7.3	0.14	72.3	2.0
Total[d]	9,677,360	1,003,470	795,755	1,386,526	11,728,730	22.3	1.2	30.9	17.8
Value	.....	$20,743,266	$489,389	$28,662,036	$7,213,159	.....	.....	.....	.....

[a] Includes 107,462 tons old tailings.
[b] Includes small amount of gold recovered by chlorination.
[c] Pan amalgamation.
[d] Porto Rico and Philippines excluded.

Figures corresponding to those in this table were collected and compiled for the United States for the first time in 1911 by the Survey, and comparison for two years for the first time can therefore now be made.

The total quantity of crude ore and old tailings treated in gold and silver mills in 1912 was 9,677,360 short tons, against 9,670,483 tons in 1911.

The great bulk of the ore treated, as shown, was milled in California, South Dakota, Alaska, Colorado, and Nevada, and here the

famous mills of the Mother Lode and Grass Valley, the Homestake, the Treadwell, and those of Cripple Creek and Goldfield and Tonopah are especially in evidence. Large numbers of other mills, however, mark the gold and silver mining industries in every mountain range and region where essentially gold and silver ores are mined. These plants range from small prospectors' mills with from 1 to 3 light stamps, simple amalgamating apparatus, and usually no concentrating tables, through the conventional 5-stamp, 10-stamp, 15-stamp, and 20-stamp mills—with plants varying widely according to local ore characteristics in weight and drop of stamps, rapidity and fineness of discharge, and arrangement for amalgamation and concentration—to the great mills above mentioned, which treat enormous tonnages daily and represent the high-water mark in milling and metallurgy of the precious metals, equipped as they are with intricate and beautifully balanced apparatus for sorting, crushing, sizing, classifying, grinding, concentrating, and amalgamation and cyanidation, and working with high extraction efficiency and admirable organization of labor and machines. The difficulties overcome in treating low-grade, refractory, and otherwise difficult ores, and the results achieved in recent years are a monument to American milling and metallurgy and an inspiration to the solution of the relatively few remaining problems of the art. From time to time new "processes" are announced and advocated for the extraction of gold from low-grade or difficult ores, and although some of these are of great merit and mark signal advances in the art as demonstrated in actual practice in mining camps where their usefulness and applicability are undoubtedly proved, some of them are mainly advertised in regions where money is always to be had for "get rich quick" schemes and where personal knowledge of mining and metallurgy are so rare that frauds readily flourish.

The tonnages treated in gold and silver mills, with increases and decreases for 1912, have been noted in connection with a preceding table.

The total production of gold produced by amalgamation in the United States in 1912 was 1,003,470 fine ounces, valued at $20,743,266, against 1,120,344 fine ounces in 1911. The decreases were mainly in Colorado, Idaho, Montana, Nevada (notably), New Mexico, Oregon, and the southern Appalachian States; the increases were chiefly in Alaska, California, and South Dakota. California, South Dakota, Alaska, and Nevada were the greatest producers of gold by amalgamation in 1912 in the order named. The total production of silver by amalgamation was 795,755 fine ounces in 1912, against 941,155 ounces in 1911. The output was largest in Texas (where pan amalgamation has been chiefly practiced) and California, ranking first and second, respectively.

The total output of gold by cyanidation in 1912 was 1,386,526 fine ounces, valued at $28,662,036, against 1,259,400 ounces in 1911. The bulk of the output was from Colorado, Nevada, South Dakota, Alaska, Arizona, California, and Montana, in the order named, in 1912. The increases were chiefly in Alaska, California, Colorado, and South Dakota (very small), and the principal decrease was in Nevada, from 504,263 ounces in 1911 to 444,633 ounces in 1912. The total output of silver by cyanidation was 11,728,730 ounces in 1912, against 8,781,552 ounces in 1911, the principal increases being in

Alaska, California, Colorado, Nevada (notably), New Mexico, and South Dakota.

In addition to these recoveries by amalgamation and cyanidation, the rapidly disappearing chlorination process yielded 16,420 fine ounces of gold in 1912, valued at $339,432, against 181,206 fine ounces in 1911. The output was 685 ounces from South Carolina and 15,735 ounces from California in 1912, against 263 ounces from South Carolina, 20,006 ounces from California, and 160,937 ounces from Colorado in 1911. (There was a very small output by chlorination in Colorado in 1912, but it is included in the recovery by cyanidation above.)

According to the percentages of the total output from all sources of gold and silver, amalgamation yielded 22.3 per cent of the gold and 1.2 per cent of the silver in 1912, against 23.9 per cent of the gold and 1.54 per cent of the silver in 1911. Cyanidation yielded 30.9 per cent of the gold and 17.8 per cent of the silver in 1912, against 26.1 per cent of the gold and 14.1 per cent of the silver in 1911. The decrease in relative output by amalgamation is therefore offset by a corresponding increased application of the cyanide process. For details of relative recoveries by States, where interesting differences are exhibited, the reader is referred to the table above. For details of consumption of quicksilver in the amalgamation process and of potassium and sodium cyanide in the cyanide process in many of the Western States, the reader is referred to the separate mine reports indicated in the prefatory note. Data as to consumption of these supplies are not yet sufficiently complete for tabulation for the entire United States.

COPPER.

By B. S. Butler.

INTRODUCTION.

In the production of metallic copper suitable for commercial purposes three distinct processes are usually required, namely, mining, smelting, and refining. The Lake Superior native copper district is the only important producer where these three processes are not entirely distinct. It is possible, therefore, to ascertain the copper output of the country by collecting statistics from the mines, from the smelters, and from the refineries, and each of these sets of figures has its advantages. The mine figures have the advantage of giving the most accurate distribution of the production but are less accurate in total quantity of copper recovered; the smelter figures permit of reasonably accurate distribution and also furnish the actual recovery of copper from the ores treated during the year; the refinery figures furnish the best measure of the copper made available for commercial uses during the year, but at this stage of manufacture the accurate distribution to the State of origin, or even the separation of copper derived from domestic and from foreign sources, is uncertain.

Statistics for 1912 showing the production of each of these stages of manufacture have been collected by the United States Geological Survey, and are presented in the following report.

Since the same material passes through the three processes of manufacture at successive periods, usually requiring two to three months from the time it is taken from the mine before it reaches the stage of refined copper, the year's production as recorded for the different stages does not represent the same materials—that is, the refinery production for the calendar year 1912 represents the mine production from about October 1, 1911, to October 1, 1912. The three sets of figures representing the successive stages of manufacture do not therefore necessarily agree, although they should not differ greatly if the condition of the industry is normal. The mine and the smelter figures will differ by the difference in the quantity of ore, matte, etc., in stock at the beginning and at the end of the year and by the difference in the quantity of copper reported by the mines and that recovered by the smelters. This difference is due to the fact that considerable copper is recovered from sulphur, lead, zinc, and siliceous ores carrying values in copper so low that the mines do not receive pay for and frequently do not report the copper content of the ore, although it is eventually recovered by the smelters. The smelter and refinery figures will differ by the increase or decrease in stock of blister, etc., at the beginning and at the end of the year and by the loss in refining.

Since the smelter production permits reasonably accurate distribution as to source by States and also gives the actual output of copper, it is adopted in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district.

SUMMARY OF STATISTICS.

The following statistical statement summarizes the copper industry in the United States in 1910, 1911, and 1912:

Summary of statistics of the copper industry in the United States in 1910, 1911, and 1912.

	1910	1911	1912
Production of copper:			
Smelter output.....pounds..	1,080,159,509	1,097,232,749	1,243,268,720
Mine production.....do....	1,088,237,432	1,114,764,197	1,249,094,891
Refinery production of new copper—			
Electrolytic.....do....	782,171,204	823,507,764	914,935,371
Lake.....do....	221,462,984	218,185,236	231,112,228
Casting and pig.....do....	68,260,688	59,577,803	57,629,296
Total domestic.....do....	1,071,894,876	1,101,270,803	1,203,676,895
Total domestic and foreign.....do....	1,422,039,135	1,433,875,026	1,568,104,478
Total new and old copper.....do....	1,610,000,000	1,648,000,000	1,843,000,000
Total ore produced.....short tons..	28,517,556	29,994,942	35,671,028
Copper ore produced.....do....	28,497,123	29,988,235	35,656,414
Average yield of copper.....per cent..	1.88	1.825	1.71
Imports.....pounds..	344,435,771	334,607,538	410,240,295
Exports.....do....	708,316,543	786,553,208	775,000,658
Consumption:			
Total new copper.....do....	732,400,000	681,753,279	775,978,332
Total new and old copper.....do....	941,400,000	895,900,000	1,051,000,000
World's production.....do....	1,903,297,003	1,954,957,560	2,255,572,320
Value of production in the United States.....	$137,180,257	$137,154,092	$205,139,338

Production of copper in the United States in 1911 and 1912.

[Smelter output, in pounds fine.]

	1911	1912		1911	1912
Alaska	22,314,889	31,926,209	Pennsylvania	661,621	248,378
Arizona	303,202,532	359,322,096	Philippine Islands	9,612	.....
California	35,835,651	31,516,471	South Dakota	1,607	23,657
Colorado	9,791,861	7,963,520	Tennessee	18,965,143	18,395,256
Idaho	4,514,116	7,182,185	Texas	105	964
Maryland	23,555	53,043	Utah	142,340,215	132,150,052
Michigan	218,185,236	231,112,228	Virginia	.....	96,753
Missouri	640,411	440,725	Washington	195,503	1,069,938
Montana	271,814,491	308,770,826	Wyoming	130,499	25,080
Nevada	65,561,015	83,413,900	Undistributed	44,645	11,413
New Mexico	2,860,400	29,170,400			
North Carolina	13,699	63,766	Total	1,097,232,749	1,243,268,720
Oregon	125,943	311,860			

GENERAL CONDITION OF INDUSTRY.

Both the smelter and the refinery production of copper in 1912 showed large increase over 1911 and was the largest in the history of the industry. Several companies that made but a small output in 1911 were large producers in 1912, and the year witnessed the beginning of important output from the Yerington district, in Nevada.

Complete statistics showing the cost of production and the price received are not available. A compilation of the cost figures of the mines giving this item in their annual reports, except for the Lake

Superior district, gives an average of 8.743 cents a pound. This list, however, includes several of the companies that produce copper at a low cost and does not include some of the companies whose copper is known to be produced at a relatively high cost. The actual average cost of copper from western mines is therefore considerably greater than the figure stated above. The average cost of production by Lake mines was about 10.28 cents per pound. It is probably safe to say that the average cost of production of the entire output did not exceed 10 cents a pound, and a large proportion of the copper was produced at a cost of 9 cents a pound or less. The average price per pound received for electrolytic and casting copper as shown by producers giving this item in their annual reports was 15.77 cents, and for Lake copper it was 16.44 cents. It is evident therefore that the copper output was made at a good profit.

There was a general advance in the cost of labor, but this item of increase was very largely offset by improvements in mining and metallurgical practices, so that the cost per ton of mining and treating ore was not materially increased. The relatively high price of metal, however, permitted the mining of lower grade material and this naturally increased the cost per pound of copper.

There has been notable progress in the metallurgy of copper in the last few years and most earnest efforts are being made to increase the metal recovery, which in some classes of ore is at present lamentably low.

Among the changes in smelting practice may be mentioned the introduction of reverberatory furnaces in the plants of the Southwest, where blast-furnace smelting has been the common practice, and the general change from the acid to the basic lined converter. In concentration, where the heaviest losses occur, in addition to improvements in the older methods, the concentration by flotation processes are being tested and attempts to make a better recovery on certain types of ore by leaching methods are also being made.

With the efforts that are being put forth, there is good reason for expecting that within a few years the percentage of recovery from concentrating ores will be materially increased and that probably it will be possible to treat certain materials, such as low-grade oxidized and partly oxidized ores, that are not now available or are treated with a high loss of metal.

In the Lake Superior district the installation of plants for fine grinding has added materially to the metal recovery.

The domestic consumption of copper showed a considerable increase over 1911, while exports showed a slight decrease. The sum of these, however, did not equal the domestic production plus the imports and there were considerable additions to the stocks of copper in various stages of manufacture.

It is apparent that in the last few years the producing capacity has increased faster than consumption and that at present, if mines and metallurgical plants are working at full capacity, an excess results. It is almost invariable, however, that interruptions to production will occur in some of the important districts, such as the labor troubles at Bingham and Ely in 1912 and the disturbed political conditions that affected the Mexican camps.

It is of interest to note that the secondary copper produced in 1912 from old scrap, etc., was equal to 27.5 per cent of the domestic con-

sumption of new copper and that the addition from this source was exceeded by the new copper produced in only three States.

In addition to an increased consumption in some of the established uses for copper, notably in the electrical industry, there are possibilities of new uses. For example, recent tests seem to indicate that the presence of small quantities of copper greatly improves steel rails and also increases the resistance of steel to atmospheric corrosion. If experience should lead to the development of these uses it would add materially to the consumption of copper.

There will be no large new producers in 1913, but those already active will be able to make a notable increase in production. This, however, will be contingent on an increase in consumption, and it seems doubtful if the demand for copper will warrant as large an increase in output in 1913 as that for 1912.

GEOLOGIC CLASSIFICATION OF COPPER DEPOSITS.

BASIS OF CLASSIFICATION.

The geologic classification of copper ores is of interest as well as the metallurgical classification. From a statistical standpoint, such a classification is somewhat difficult for the reason that in a single district two or more types may occur and in some instances the amount of copper derived from each has not been recorded. The approximate amount derived from the several types can, however, usually be ascertained.

It is apparent that in a statistical treatment only broad groups can be recognized, as the data are not available for ascertaining the output from types of minor commercial importance, although they may be of great scientific interest.

A classification may be made on the basis of the geologic age of the deposits which is usually the same for all deposits in a given district, which method groups together deposits differing greatly in mineralogic character and geologic occurrence; or, on the other hand, a classification may be based on geologic occurrence and mineralogic character, by which method deposits of widely separated ages are thrown into the same group.

CLASSIFICATION ACCORDING TO GEOLOGIC AGE.

Lindgren [1] has given an age classification of metalliferous ores to which the copper deposits of the United States of known age may be readily referred, although unfortunately there are some of the deposits whose age has not been positively determined.

In varying quantity copper minerals are of widespread and general occurrence both in geographic distribution and in geologic age. It is doubtful if there has been an important period of deposition of metallic minerals, with the exception of iron ores, in which copper minerals have not been deposited to a greater or less extent. In spite of this very universal distribution of the metal, all the deposits of known age that have made important contributions to the country's output can be referred to four periods which in general correspond to periods of igneous activity.

[1] Lindgren, Waldemar, Metallogenetic epochs: Econ. Geology, vol. 4, 1909, p. 409.

Pre-Cambrian periods.—The pre-Cambrian, covering as it does a very long portion of geologic time, probably includes deposits formed at widely separated times and certainly of wide geographic distribution and of very different character. The important deposits of this age that have been developed to the present time are, however, few in number. The larger producers have been the Lake Superior district of Michigan, the Jerome district of Arizona, and the Encampment district of Wyoming; some lesser deposits in the West and possibly some of the Appalachian deposits should be classed with them. Deposits of this age have yielded approximately 33 per cent of the total output of the country, and they yielded about 21.4 per cent of the 1912 output.

Paleozoic era.—The deposits of the Paleozoic era are confined to the Appalachian region. They were formerly considered to be of pre-Cambrian age, but it is now known that several of the Appalachian deposits occur in metamorphosed sediments of early or middle Paleozoic age, and it is probable that the same age will be shown for the inclosing rock of more of them. The time in the Paleozoic when the deposits were formed is somewhat uncertain. Some of them have been described by geologists as being formed before the great period of regional metamorphism which is believed to have occurred in the late Paleozoic; other investigators in studying other deposits have found that the ores were formed after the period of metamorphism. From these descriptions one is led to the conclusion that deposition of copper ore both preceded the regional metamorphism and also followed it. As the data are not now available for a separation of these, they will be considered together—and, indeed, it may be found that most of the deposits were formed during the period of metamorphism. The most important production has been made from the Ducktown district of Tennessee, the Great Gossan lead of Virginia and North Carolina, the Virgilina district of Virginia and North Carolina, and the Ely district of Vermont. Deposits of this age have yielded between 1.5 and 2 per cent of the output of the country, and they produced about 1.5 per cent of the 1912 output.

Mesozoic era.—The third important period of copper deposition occurred in the Mesozoic era, preceding the main deposition of Cretaceous sediments and probably at about the close of the Jurassic or in the early Cretaceous, though some of the deposits included in this group are believed to have been formed early in Mesozoic time. These deposits are associated with the great masses of monzonitic and dioritic intrusives that extend through the far Western States from British Columbia on the north to Mexico on the south.

Among the more important of these deposits are those of the Shasta district and the "foothills" district of California, together with numerous districts of Idaho, eastern Washington, and western Nevada, which have not made important production, and the deposits in Alaska. To this general period are assigned the deposits of the Bisbee district, Arizona. Ransome considers that the deposits at Globe and Ray, Ariz., are probably of this age, though the field evidence is not conclusive. It is probable that the deposits of the Silverbell district, Arizona, will prove to be of the same age. Spencer considers the deposits of the Ely district, Nevada, to be of this age, and Ransome assigns the Yerington deposits to late Jurassic or early Cretaceous.

If the deposits enumerated above and numerous smaller deposits are correctly assigned, the output from ores of this age amounts to over 17 per cent of the total output of the country and about 31.8 per cent of the production in 1912.

Tertiary period.—The fourth important period of copper deposition occurred in Tertiary time and was associated with the extensive granitic and monzonitic intrusions in the Rocky Mountain and eastern Great Basin regions extending from Montana on the north to Mexico on the south. The exact age of these intrusions and the associated ore deposits can not always be fixed, but the intrusives cut Cretaceous rocks and in some instances Miocene rocks, and it is probable that the deposits are from early to middle Tertiary and possibly some of them late Tertiary in age.

To this period are assigned the deposits of Butte, Mont., of the Morenci-Metcalf district, Arizona, of the Santa Rita district, New Mexico, and probably the deposits of the Bingham and Frisco districts, Utah, together with many deposits of mixed lead-silver-copper ores in Colorado, Utah, and New Mexico that have yielded considerable copper. If the age assigned to the deposits included in this period is correct, ores of this age have yielded about 45.3 per cent of the total output of the country, and they produced about 45.3 per cent of the output in 1912. So far as indicated by past and present production this was the most important of the epochs of copper deposition.

Other periods.—In addition to these deposits and periods mentioned there are deposits along the Pacific coast associated with basic igneous rocks of early Mesozoic age. These deposits have not yielded important quantities of copper. In the east the copper deposits associated with the Triassic traps may be mentioned, though the copper derived from them is unimportant. There is a widespread occurrence of what Lindgren has designated "Cretaceous and later concentrations in sedimentary rocks." Deposits of this character occur largely in the "Red Beds" in Arizona, New Mexico, Utah, Colorado, and Texas, and although they have been of little commercial importance in the past there is a possibility of their proving a source of production at some future time.

CLASSIFICATION ACCORDING TO OCCURRENCE.

With reference to mineral composition and geologic occurrence, the copper deposits may be grouped into six principal classes and the approximate quantity derived from each group may be ascertained. In a general way, this grouping also classifies the ores according to the metallurgical treatment to which they are best adapted.

In a classification of this kind that is adapted to a general statistical treatment, it is apparent that too fine distinctions can not be drawn, since the necessary data are not available, and in some districts where copper has been derived from more than one type of deposit it is not possible to obtain exact figures of the output of each. Moreover, even in a very general classification, there is uncertainty in the case of some deposits as to which type they should be assigned.

The following grouping is presented as of interest from a statistical standpoint but is not suggested as an adequate classification of copper ores where data are available for greater refinement:

Lenticular deposits in schistose and igneous rocks.—Under this head are considered deposits, whose primary mineralization consisted mainly

of sulphide of iron, copper, and zinc, replacing schistose rocks. The schistosity may be either the result of regional metamorphism or of the local shearing of igneous rocks. This class of deposit usually has a more or less lenticular form. The primary ores are generally a rather low-grade smelting ore but are susceptible of cheap mining and metallurgical treatment. In many of these deposits the upper part contains a zone of enriched sulphides. To this type may be referred the deposits of the Jerome district, Arizona; the "foothill" and Shasta County districts, California; the Ducktown district, Tennessee; many smaller deposits in the Appalachian region, including deposits in New Hampshire, Vermont, Virginia, Alabama, and Georgia, and the deposits of the Prince William Sound district, Alaska. The output from this type of deposit has been about 8.4 per cent of the total from the country; in 1912 it was about 6.9 per cent.

Native copper in volcanic rocks.—Under this type are grouped deposits in which the copper occurs native in irregular ore shoots in certain beds of volcanic or interbedded volcanic and sedimentary rocks. The ores are nearly all of a concentrating grade, the metal resulting from the concentration being subjected to a special refining process. The Lake Superior district, Michigan, is the only one of this type that has made important production, though similar deposits occur in Pennsylvania, Maryland, New Jersey, and Alaska. The output from this type is essentially that of the Lake Superior district. It has contributed 29.53 per cent of the total output and it constituted 18.58 per cent of the production in 1912.

Replacement deposits in sedimentary rocks.—Under this heading are included what are commonly known as contact deposits and deposits formed by the replacement of sediments along fissures. The primary mineralization in this type consists of iron and copper sulphides, together with varying amounts of other sulphides, oxides, and silicates, usually replacing limestone or other highly calcareous rocks. Alteration has frequently been extensive in these deposits and much of the copper has been derived from oxidized ores. Most of the ores are of smelting grade. Some of the oxidized ores carry high copper values, and the primary sulphide ores, though relatively low in copper content, are cheaply treated. To this type of deposit may be referred the output of the Bisbee and Silverbell districts, Arizona, and the Yerington district, Nevada, and part of the Globe and Morenci-Metcalf districts, Arizona; part of the production from Bingham, Utah; Santa Rita, N. Mex.; Ely, Nev.; southeastern Alaska; the Copper River district, Alaska; and many smaller districts. To this type also belongs the output from many lead-silver districts in which copper is of minor importance. Among these are Leadville, Colo., Tintic and Park City, Utah, and many others.

The output from this type of ore has been approximately 20.5 per cent of the total and was about 23 per cent of the production in 1912.

Disseminated deposits.—Under this type are considered deposits in which the ore minerals occur in small veins or grains disseminated through altered igneous, schistose, or sedimentary rocks. This includes what are frequently referred to as "porphyry" ores. The term "disseminated" is preferable, for many of the ores of this type do not occur in porphyritic rocks.

The primary mineralization commonly consists of pyrite and chalcopyrite with varying quantities of other sulphides. The deposits have

usually undergone sulphide enrichment, the copper content of the minerals near the surface being in part taken in solution and redeposited, usually as chalcocite, on the sulphides lower down. Some deposits of this type that have not been enriched are worked, and in still others native copper and cuprite are among the important ore minerals. The ore is usually low-grade concentrating ore, but it occurs in large bodies and is cheaply mined and milled.

Any separation of this type from that of replacement fissure-vein deposits must be purely arbitrary, but it seems desirable to make such a separation. The principal deposits of this type are those of the Bingham and Frisco districts, Utah; Ely district, Nevada; Morenci-Metcalf, Miami, and Ray districts, Arizona; Santa Rita, N. Mex., and others that may prove of future importance. The output from this type of deposit, which has been produced largely during the last few years, is over 8 per cent of the total and was over 26.4 per cent of the production in 1912.

Fissure-vein deposits.—Under this type are included deposits formed in fissure veins and as a replacement along such veins. As already stated, there is no sharp line between this type and that of the disseminated deposits. In the principal deposits of this type, those at Butte, Mont., much of the ore is of a smelting grade, and there are other differences that make it desirable to keep it separate from the disseminated deposits. The primary mineralization of this class consists of sulphides of iron, copper, and zinc in varying amounts, with small amounts of other sulphides filling fissures and replacing the wall rocks. Enrichment in this type as in the preceding has been important in producing the commercial ore. The ores are of both smelting and concentrating grades.

The great deposit of this type is that at Butte, Mont., though smaller deposits occur in many places in the West and to some extent in the Appalachian region. The output from this type is approximately 33.5 per cent of the total and was about 24.8 per cent of the production in 1912.

Disseminated deposits of sedimentary rocks.—To the classes named should be added the disseminated deposits in little-altered or unaltered sedimentary rocks, usually referred to as the "Red Beds" deposits. In this class the primary mineralization ordinarily consists of chalcocite disseminated through sandstones, shale, and conglomerate. This may be partly or entirely altered to carbonates, oxides, and silicates. This type has not yielded important amounts of copper in this country, but the deposits are numerous, especially in Texas, New Mexico, Arizona, Colorado, and Utah, and they may prove of commercial importance at some future time.

PRODUCTION.

SMELTER AND MINE PRODUCTION.

GENERAL STATEMENT.

The production of copper in 1912 by smelters from copper-bearing materials from the United States was 1,243,268,720 pounds, valued at $205,139,338,[1] as compared with 1,097,232,749 pounds, valued at $137,154,092, in 1911. The production for 1912 was the largest in the history of the industry, surpassing that of 1911 by 146,035,971

[1] For discussion of prices, see section on prices on a subsequent page.

pounds, or 13.31 per cent, in quantity and by $67,985,246, or 49.57 per cent, in value.

The yearly production of copper in the United States from 1845 to 1912, inclusive, together with the actual and relative changes from each preceding year, is shown in the following table:

Magnitude and growth of copper production in the United States from 1845 to 1912, inclusive.

Year.	Production.	Increase.		Average annual increase, by decades.	
	Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
1845	224,000				
1846	336,000	112,000	50.0		
1847	672,000	336,000	100.0	246,400	50.0
1848	1,120,000	448,000	67.0		
1849	1,568,000	448,000	40.0		
1850	1,456,000	a 112,000	a 7.1		
1851	2,016,000	560,000	38.4		
1852	2,464,000	448,000	22.2		
1853	4,480,000	2,016,000	81.8		
1854	5,040,000	560,000	12.5		
1855	6,720,000	1,730,000	33.3		
1856	8,960,000	2,240,000	33.3	1,472,200	28.5
1857	10,752,000	1,792,000	20.0		
1858	12,320,000	1,568,000	14.6		
1859	14,112,000	1,792,000	14.5		
1860	16,128,000	2,016,000	14.3		
1861	16,800,000	672,000	4.1		
1862	21,160,000	4,360,000	26.0		
1863	19,040,000	a 2,120,000	a 10.0		
1864	17,920,000	a 1,120,000	a 5.9		
1865	19,040,000	1,120,000	6.3		
1866	19,936,000	896,000	4.7	1,209,600	6.2
1867	22,400,000	2,464,000	12.3		
1868	25,984,000	3,584,000	16.0		
1869	28,000,000	2,016,000	7.7		
1870	28,224,000	224,000	.8		
1871	29,120,000	896,000	3.2		
1872	28,000,000	a 1,120,000	a 3.8		
1873	34,720,000	6,720,000	24.0		
1874	39,200,000	4,480,000	12.9		
1875	40,320,000	1,120,000	2.9		
1876	42,560,000	2,240,000	5.6	3,225,600	8.2
1877	47,040,000	4,480,000	10.0		
1878	48,160,000	1,120,000	2.4		
1879	51,520,000	3,360,000	7.0		
1880	60,480,000	8,960,000	17.4		
1881	71,680,000	11,200,000	18.5		
1882	90,646,232	8,966,232	12.5		
1883	115,526,053	24,886,221	27.4		
1884	144,946,653	29,420,600	25.5		
1885	165,875,766	20,929,113	14.4		
1886	156,735,381	a 9,140,385	a 5.5	18,928,949	14.8
1887	180,920,524	24,185,143	15.4		
1888	226,361,466	45,440,942	25.0		
1889	226,775,962	414,496	.2		
1890	259,763,092	32,987,130	14.5		
1891	284,121,764	24,358,672	9.4		
1892	344,998,679	60,876,915	21.4		
1893	329,354,398	a 15,644,281	a 4.5		
1894	354,188,374	24,833,976	7.5		
1895	380,613,404	26,425,030	7.4		
1896	460,061,430	79,448,026	20.0	34,635,407	9.4
1897	494,078,274	34,016,844	7.4		
1898	526,512,987	32,434,713	6.6		
1899	568,666,921	42,153,934	8.0		
1900	606,117,166	37,450,245	6.6		
1901	602,072,519	a 4,044,647	a .7		
1902	659,508,644	57,436,125	9.5		
1903	698,044,517	38,535,873	5.8		
1904	812,537,267	114,492,750	16.4		
1905	888,784,267	76,247,000	11.0		
1906	917,805,682	15,897,839	1.7	47,404,234	6.1
1907	868,996,491	a 48,809,191	a 5.3		
1908	942,570,721	73,074,230	8.4		
1909	1,092,951,624	150,380,903	15.9		
1910	1,080,159,509	a 12,792,115	a 1.2		
1911	1,097,232,749	17,073,240	1.6		
1912	1,243,268,720	146,035,971	13.3		
Total	17,619,869,236				

a Decrease.

The figures, except for 1912, are taken from the previous volumes of Mineral Resources of the United States. Statistics from 1882 to 1912, inclusive, are based on the returns to the United States Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the Survey from the best sources available. Reliable figures for years previous to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and, since 1880 when Arizona and Montana became important producers, a very rapid growth.

Only five times since 1880 has the annual production shown a decrease from that of the preceding year and in every instance the decrease has been slight and has been more than recovered the following year. The years showing a decrease are 1886, 1893, 1901, 1907, and 1910. At several other times the increase has been slight. In most instances where there has been a decrease it may be attributed to a general condition of financial and business depression, which has resulted in a decrease in the demand for copper and other materials necessary to the expansion of industries. In three instances a slight decrease appears to have been due to the fact that the producing capacity of the country had been increased out of proportion to the demand for domestic consumption and export, and a temporary curtailment in production became necessary to permit the absorption of accumulated stocks. This, coupled with attempts at artificial control of prices, appears to have been the case in 1886 and also in 1901, and the decrease in production in 1910 may be attributed to a similar cause. The large increase in 1912 which, with one exception, that of 1909, was the largest in the history of the industry, was due to the output from mines that have reached the producing stage during 1912 or had previously made but relatively small production. Some of these new producers were operated at only partial capacity for a portion of the year and their normal production will be considerably greater than that for 1912.

So far as the producing capacity of the country is concerned, another considerable increase in 1913 is possible. The large production in 1912, however, resulted in the accumulation of additional stocks of copper in various stages of manufacture and further large increase in production is not likely unless there is a material increase in the consumption of the metal.

SMELTER RETURNS.

The figures of smelter production for 1912 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries to secure the accurate distribution of the output, sincere thanks are extended. The following list gives the names of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1912. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

Copper smelting plants that treated materials from the United States in 1912.

Location.	Company.	Final copper product.
UNITED STATES.		
Arizona:		
Clifton	Arizona Copper Co.	Blister.
Do.	Shannon Copper Co.	Do.
Douglas	Calumet & Arizona Mining Co.	Do.
Do.	Copper Queen Consolidated Mining Co.	Do.
Globe	Old Dominion Copper Mining & Smelting Co.	Do.
Hayden	American Smelting & Refining Co.	Do.
Humboldt	Consolidated Arizona Smelting Co.	Do.
Jerome	United Verde Copper Co.	Do.
Morenci	Detroit Copper Mining Co.	Do.
Swansea	Swansea Consolidated Gold & Copper Co.	Do.
Tucson	Pioneer Smelting Co.	Matte.
California:		
Campo Seco	Penn Mining Co.	Do.
Kennett	Mammoth Copper Mining Co.	Blister.
Martinez	Mountain Copper Co.	Do.
Needles	Needles Smelting & Refining Co.	Matte.
Colorado: Salida	Ohio & Colorado Smelting & Refining Co.	Do.
Maryland: Baltimore	Baltimore Copper Smelting & Rolling Co.	Electrolytic.
Michigan:		
Hancock	Lake Superior Smelting Co.	Anodes and lake.
Do.	Quincy Mining Co.	Do.
Houghton	Michigan Smelting Co.	Do.
Hubbell	Calumet & Hecla Mining Co.	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co.	Blister.
Butte	East Butte Copper Mining Co.	Do.
Great Falls	Anaconda Copper Mining Co.	Blister and electrolytic.
Nebraska: Omaha	American Smelting & Refining Co.	Blister.
Nevada:		
Ludwig	Mason Valley Mines Co.	Matte.
McGill	Nevada Consolidated Copper Co.	Blister.
New Jersey: [a]		
Chrome	United States Metals Refining Co.	Electrolytic and casting.
Maurer	American Smelting & Refining Co.	Electrolytic.
Newark	Balbach Smelting & Refining Co.	Electrolytic and casting.
Perth Amboy	Raritan Copper Works.	Electrolytic.
New Mexico: San Pedro	Santa Fe Gold & Copper Mining Co.	Matte.
New York:		
Black Rock	Buffalo Smelting Works.	Lake and electrolytic.
Laurel Hill	Nichols Copper Co.	Electrolytic and casting.
Tennessee:		
Copperhill	Tennessee Copper Co.	Blister.
Isabella	Ducktown Sulphur, Copper & Iron Co. (Ltd.)	Matte.
Texas: El Paso	American Smelting & Refining Co.	Blister.
Utah:		
Garfield	Garfield Smelting Co.	Do.
International	International Smelting & Refining Co.	Do.
Virginia: West Norfolk	Virginia Smelting Co.	Matte.
Washington: Tacoma	Tacoma Smelting Co.	Blister and electrolytic.
CANADA.		
British Columbia:		
Grand Forks	Granby Consolidated Mining, Smelting & Power Co.	Blister.
Greenwood	British Columbia Copper Co. (Ltd.)	Do.
Trail	Consolidated Mining & Smelting Co. of Canada.	Matte.
MEXICO.		
Aguas Calientes:		
Aguas Calientes	American Smelting & Refining Co.	Blister.
Cananea	Cananea Consolidated Copper Co.	Do.

[a] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister rom material solely of foreign origin.

During the year 46 copper smelting and refining plants treated material from the United States. Of these, 41 were domestic plants and 5 were foreign—3 located in British Columbia and 2 in Mexico.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. In the case of blister copper the figures represent the fine copper content. Some casting copper

is produced direct from ore and matte and this is included in the smelter production.

The following table shows approximately the production of blister copper from different sections. Smelters that produced only matte are not included in this distribution.

Production of copper in 1912, apportioned according to locality in which smelted to blister, in pounds.

Locality.	Domestic.	Foreign.	Total.
Arizona	318,000,000	31,700,000	349,700,000
Montana	308,900,000	.....	308,900,000
Utah and Nevada	211,700,000	.....	211,700,000
California and Washington	54,500,000	20,500,000	75,000,000
All others	316,100,000	76,000,000	392,100,000
Total by domestic plants	1,209,200,000	128,200,000	1,337,400,000
Total by foreign plants from domestic ore, concentrates, and matte	34,000,000	.....	.....
Grand total from domestic ores	1,243,200,000	.....	.....

As will be seen by comparing this table with the table showing the production by States and districts, ore, with few exceptions, is reduced to blister copper before being shipped from the district. The exceptions in the case of important producing States are Michigan and Colorado. In the case of Michigan the shipping product is high-grade concentrate transported by Lake boats to Buffalo at a low cost; in the case of Colorado the copper is largely produced as lead furnace matte and is shipped to Omaha for further treatment. Considerable matte produced in California is shipped east for conversion.

Arizona treated considerable Mexican ore, and ore and matte from British Columbia were treated in this country. Ore and concentrates from the United States were smelted in Mexico. The output of the Miami mine of the Globe district was treated at Cananea, and ore from the United States was smelted in British Columbia and returned to this country. A large tonnage of ore and matte from foreign sources was treated by the seaboard smelters.

During 1912 matte smelters produced a total of about 30,500,000 pounds of copper from domestic ores, as compared with 40,800,000 pounds produced in 1911. In most instances the product of these plants is shipped to near-by blister smelters for conversion.

MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1912. These mines reported 1,249,094,891 pounds of copper, or 5,826,171 pounds more than the smelters. The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. In the case of mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion there is likely to be considerable discrepancy, as the mines may report a considerable quantity that has not reached the stage of blister by the close of the year and is consequently not included in the smelter production, or material

that was reported by the mines in one year may be treated by the smelters the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or at the close of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. A number of operators report the copper in their ores and concentrates on the basis of assay content, in which case it exceeds the smelter recovery from the same material by the quantity lost in smelting. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for and, consequently, is not always reported by the mines.

The following table shows the output of copper from domestic ores for the last seven years as reported by mines, smelters, and refineries:

Production of copper from domestic ores as reported by the mines, the smelters, and the refineries, 1906–1912, in pounds.

Year.	Mine.	Smelter.	Refinery.
1906	916,971,387	917,805,682	887,682,387
1907	847,151,015	868,996,491	784,271,427
1908	956,840,578	942,570,721	919,111,414
1909	1,126,521,126	1,092,951,624	1,065,564,921
1910	1,088,237,432	1,080,159,509	1,071,894,876
1911	1,114,764,197	1,097,232,749	1,101,270,803
1912	1,249,094,891	1,243,268,720	1,203,676,895
Total	7,299,580,626	7,242,985,496	7,033,472,723

As shown by this table, in the period of seven years the quantity of copper reported by the mines exceeded that reported by the smelters by about 0.7 per cent.

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

It appears that although theoretically the output reported by the mines should be considerably in excess of that reported by the smelters, this difference in the last seven years has been nearly balanced by the copper recovered from lead, zinc, gold, silver, and sulphur ores which carry copper values so low that they are not paid for and consequently have not usually been reported by the mines.

PRODUCTION BY STATES.

Twenty-one States and Territories contributed to the copper production of 1912. The following table shows the mine and the smelter output of individual States for 1911 and 1912.

According to smelter returns, the three leading States, Arizona, Montana, and Michigan, produced 72 per cent of the total output of 1912, the same as for 1911, and the eight leading States, including Utah, Nevada, Alaska, California, and New Mexico, produced over 97 per cent of the total output in 1912.

Production of copper by smelter returns in 1911 and 1912, compared with mine returns for same years, by States, in pounds.

State.	Production.					
	1912				1911	
	Rank.	Percentage of total.	Smelter returns.	Mine returns.	Smelter returns.	Mine returns.
Alaska	6	2.56	31,926,209	29,230,491	22,314,889	27,267,878
Arizona	1	28.90	359,322,096	365,038,649	303,202,532	306,141,538
California	7	2.53	31,516,471	33,451,672	35,835,651	36,316,136
Colorado	10	.64	7,963,520	7,107,303	9,791,861	8,024,488
Idaho	11	.57	7,182,185	7,492,152	4,514,116	5,152,937
Maryland	18	.....	53,043	(a)	23,555	(a)
Michigan	3	18.58	231,112,228	218,138,408	218,185,236	219,840,201
Missouri	13	.03	440,725	440,725	640,411	640,411
Montana	2	24.83	308,770,826	309,738,873	271,814,491	272,847,705
Nevada	5	6.70	83,413,900	86,477,494	65,561,015	67,377,518
New Mexico	8	2.34	29,170,400	34,030,964	2,860,400	4,057,040
North Carolina	17	.....	63,766	75,915	13,699	.....
Oregon	14	.02	311,860	260,429	125,943	93,136
Pennsylvania	15	.01	248,378	a 594,022	661,621	a 665,110
Philippine Islands	.....	.....	.....	.....	9,612	2,205
South Dakota	20	.....	23,657	.....	1,607	.....
Tennessee	9	1.47	18,395,256	18,483,173	18,965,143	18,850,276
Texas:	22	.....	964	721	105	.....
Utah	4	10.62	132,150,052	137,307,485	142,340,215	146,960,827
Virginia	16	.01	96,753	112,835	.....	90,000
Washington	12	.08	1,069,938	1,086,010	195,503	318,207
Wyoming	19	.....	25,080	27,570	130,499	118,584
Unapportioned	21	.....	11,413	.....	44,645	.....
Total	.....	.....	1,243,268,720	1,249,094,891	1,097,232,749	1,114,764,197

a Pennsylvania and Maryland combined.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, although the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced.

The following table shows the production from 1903 to 1912 for each State for which separate statistics are available.

In the report for 1910 the annual production by States since 1845 is given. This report can be procured on application to the Director of the United States Geological Survey, Washington, D. C.

Production of copper in the United States, 1903–1912, by States, in pounds.

State.	1903	1904	1905	1906	1907
Alaska	1,339,590	2,043,586	4,900,866	8,685,646	7,034,763
Arizona	147,648,271	191,602,958	226,854,461	262,566,103	256,778,437
California	17,776,756	28,529,023	16,697,489	28,153,202	33,696,602
Colorado	4,158,368	9,506,944	9,404,830	7,427,253	13,998,496
Idaho	778,906	2,158,858	7,321,585	8,578,046	9,707,299
Michigan	192,400,577	208,309,130	230,287,992	229,695,730	219,131,503
Montana	272,555,854	298,314,804	314,750,582	294,701,252	224,263,789
New Mexico	7,300,832	5,368,666	5,334,192	7,099,842	10,140,140
Nevada	150,000	.....	413,292	1,090,635	1,998,164
Oregon	.....	.....	846,615	545,859	518,694
South Dakota	173,202	100,000	38	.....	.....
Utah	38,302,602	47,062,889	54,083,506	50,329,119	66,418,370
Washington	80,758	663,694	223,328	290,823	122,263
Wyoming	1,023,189	3,565,629	2,530,531	106,177	3,026,004
Eastern States	} 13,855,612	15,211,086	15,134,960	{	.....
Southern States				.....	.....
Middle States				{	.....
Eastern States and unapportioned	.....	.....	.....	18,535,995	22,161,967
Lead desilverizers and unapportioned	a 500,000	a 100,000	.....	.....	.....
Total	698,044,517	812,537,267	888,784,267	917,805,682	868,996,491

a Based partly on estimates.

Production of copper in the United States, 1903–1912, by States, in pounds—Contd.

State.	1908	1909	1910	1911	1912
Alaska	4,438,836	4,057,142	4,311,026	22,314,889	31,926,209
Arizona	289,523,267	291,110,298	297,250,538	303,202,532	359,322,096
California	39,643,835	53,568,708	45,760,200	35,835,651	31,516,471
Colorado	13,943,878	11,485,631	9,307,497	9,791,861	7,963,520
Idaho	7,256,086	7,096,132	6,877,515	4,514,116	7,182,185
Michigan	222,289,584	227,005,923	221,462,984	218,185,236	231,112,228
Montana	252,503,651	314,858,291	283,078,473	271,814,491	308,770,826
New Mexico	4,991,351	5,031,136	3,784,609	2,860,400	29,170,400
Nevada	12,241,372	53,849,281	64,494,640	65,561,015	83,413,900
Oregon	271,191	245,403	22,022	125,943	311,860
South Dakota	5,471	41,988	43	1,607	23,657
Utah	71,370,370	101,241,114	125,185,455	142,340,215	132,150,052
Washington	162,201	120,611	65,021	195,503	1,069,938
Wyoming	2,416,197	433,672	217,127	130,499	25,080
Eastern States and unapportioned	21,513,431	22,806,294	18,342,359	20,358,791	19,310,298
Total	942,570,721	1,092,951,624	1,080,159,509	1,097,232,749	1,243,268,720

Total production of copper by States, 1845–1912, and percentage and rank of each State.

State.	Quantity.	Percentage.	Rank.
Alaska	91,052,553	0.52	10
Arizona	3,853,655,207	21.86	3
California	518,487,079	2.94	5
Colorado	221,507,444	1.26	8
Idaho	66,253,985	.38	11
Michigan	5,205,717,606	29.53	2
Montana	5,907,024,710	33.51	1
New Mexico	124,353,963	.71	9
Nevada	286,914,012	1.63	7
Oregon	2,887,587	.02	15
South Dakota	5,279,077	.03	13
Utah	929,194,840	5.27	4
Washington	3,243,222	.01	14
Wyoming	25,998,979	.15	12
Eastern States and unapportioned	384,308,972	2.18	6
Total	17,625,869,236	100.00	.....

The totals in the preceding table show the copper output of each important copper-producing State, except those on the Atlantic coast since the beginning of the industry. Some copper was produced in New Mexico in the early years of the last century, but the exact quantity is not known. It was not large as measured by present production of the metal. A little copper was also produced in Michigan prior to 1845, but it was not sufficient in quantity to be of importance. Considerable copper was produced in the Eastern States prior to 1845.

Under "Eastern States and unapportioned" is included some copper classed as "lead desilverizers, etc.," in the earlier reports of the Survey. This should properly be credited to some of the Western States. The output of the Central States, except Michigan, is also included under this head. Statistics for the individual Eastern States have not been compiled, but it may be stated that approximately 259,000,000 pounds has been derived from Tennessee. Of the remainder, Vermont and Virginia have made the largest contributions, and some copper has been produced by practically all of the Appalachian States.

It will be noted that Montana, Michigan, and Arizona stand out as the three great copper-producing States. Montana ranks first, with more than one-third of the entire output of the country; Michigan ranks second, with slightly less than one-third; and Arizona

ranks third, with over one-fifth of the total output. Utah, ranking next in order, has produced about one-twentieth of the total output. The three leading States have produced 84.9 per cent of the entire production.

It will be noted by reference to the table showing the output for 1912 that these three States still maintain their preeminence, producing 81 per cent of the total output in 1908, 76 per cent in 1909, 74 per cent in 1910, and 72 per cent in 1911 and 1912. The relative importance of other States, however, is much greater in recent years, Utah producing 10.6 per cent of the total output in 1912.

In the following table is given the blister copper output of the leading districts of the country in 1912:

Blister copper production of principal districts in 1912, in pounds.

District or region.	State.	Approximate smelter output.	Percentage of total production.	Rank.
Butte	Montana	308,000,000	24.77	1
Lake Superior	Michigan	231,100,000	18.59	2
Bisbee	Arizona	140,000,000	11.26	3
Bingham	Utah	112,000,000	9.01	4
Morenci-Metcalf	Arizona	79,900,000	6.43	5
Ely	Nevada	67,400,000	5.42	6
Globe	Arizona	61,600,000	4.95	7
Mineral Creek (Ray)	do	34,600,000	2.78	8
Alaska (all districts)		31,900,000	2.57	9
Jerome	Arizona	31,680,000	2.55	10
Shasta County	California	26,000,000	2.09	11
Santa Rita	New Mexico	25,000,000	2.01	12
Ducktown	Tennessee	18,395,000	1.48	13
Yerington	Nevada	14,700,000	1.18	14
Tintic	Utah	13,000,000	1.05	15
Courtland	Arizona	8,000,000	.64	16
Calaveras County	California	6,000,000	.48	17
Coeur d'Alene	Idaho	3,840,000	.31	18
Frisco	Utah	3,000,000	.24	19
Lordsburg	New Mexico	3,000,000	.24	20
Alder Creek	Idaho	2,860,000	.23	21
Leadville	Colorado	2,065,000	.17	22
Ludlow	California	1,850,000	.15	23
Pima	Arizona	1,700,000	.14	24
Palmetto	do	1,500,000	.12	25
San Juan-Ouray	Colorado	1,463,000	.12	26
Uinta-Summit (Park City)	Utah	1,450,000	.12	27
Big Bug	Arizona	1,200,000	.10	28
Pioneer	do	1,100,000	.09	29
Gilpin County	Colorado	1,025,000	.08	30
Total		1,235,328,000	99.37	.....
All others		7,932,000	.63	.....
Grand total		1,243,260,000	100.00	.....

As shown in this table, 30 districts in 1912 each produced 1,000,000 or more pounds of blister copper.

These 30 districts produced 99.37 per cent of the total output of the country. In 1911, 23 districts each produced in excess of 1,000,000 pounds, the 23 districts producing 99.04 per cent of the total. Fifteen districts in 1912 produced in excess of 10,000,000 pounds, the output of the 15 districts being 96.14 per cent of the total. Thirteen districts in 1911, yielding over 10,000,000 pounds, produced 96.36 per cent of the total. In 1912 four districts yielded in excess of 100,000,000 pounds each, these districts producing 63.63 per cent of the total. In 1911 the same districts yielded 69.92 per cent of the total.

The following table shows the output of the principal copper-producing districts of the United States from the beginning of produc-

tion to the close of 1912. For the later years the statistics are compiled from reports furnished to the United States Geological Survey by the producing companies. For the earlier years the figures are taken mainly from reports on the several districts by members of the Survey.

Total blister copper production of principal districts to the close of 1912, in pounds, and percentage of total and rank of each.

District.	State.	Production began—	Pounds.	Percentage of total production.	Rank
Butte	Montana	1868	5,894,200,000	33.44	1
Lake Superior	Michigan	1845	5,205,700,000	29.53	2
Bisbee	Arizona	1880	1,555,200,000	8.82	3
Morenci-Metcalf	do	1873	1,034,100,000	5.87	4
Bingham	Utah	1896	702,500,000	3.99	5
Jerome	Arizona	1883	634,880,000	3.60	6
Globe	do	1881	440,900,000	2.50	7
Shasta County	California	1897	391,900,000	2.22	8
Ely	Nevada	1908	257,300,000	1.46	9
Ducktown	Tennessee	1850	249,055,000	1.41	10
Santa Rita	New Mexico	1800 (?)	129,400,000	.74	11
Foothills Belt	California	1862	115,500,000	.66	12
Tintic	Utah	1880 (?)	103,900,000	.59	13
Total			16,714,535,000	94.83	
All others			911,325,000	5.17	
Grand total			17,625,860,000	100.00	

Thirteen districts situated in eight States have each contributed in excess of 100,000,000 pounds to the copper output of the country. Four of these districts are in Arizona, 2 each in California and Utah, and 1 each in Montana, Michigan, Nevada, New Mexico, and Tennessee. Two districts stand out prominently. They are the Butte district, Montana, which has contributed slightly over one-third of the output of the country, and the Lake Superior district, Michigan, with a production of a little less than one-third of the total output. Bisbee, ranking third, has yielded 8.8 per cent of the total production. The 13 districts have yielded 94.83 per cent of the total output of the United States since 1845.

It will be seen by a comparison of the table showing the total output of the leading districts with the table showing the output of the leading districts in 1912 that the first 7 are the same, but that the order is changed to some extent.

It is noteworthy that there is not a single instance where one of the leading copper districts of the United States, several of which have been active producers for a period of 30 years or more, has been worked out or showed a decrease in its ability to produce copper.

TONNAGE AND YIELD OF COPPER ORES.

COPPER-BEARING ORES PRODUCED IN 1912.

The following tables show the tonnage and the yield in copper of the ores produced by the mines of the United States in 1912. The figures are taken from the mine reports referred to in the prefatory note, which form a part of the volume on Mineral Resources issued annually by the United States Geological Survey. The close agreement between the output as reported by the mines and the actual recovery of metal by the smelters indicates that the tenor of ores as reported by the mines is very close to the actual recovery of metal. The classification of some of the complex western ores is a

difficult and more or less arbitrary matter. Under copper ores are classed those which contain 2½ per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is an important constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for values in other metals. No attempt has been made to compile tables showing the tonnage and yield of this group of copper-bearing ores, but together with old slags, etc., they have yielded a total of 32,043,636 pounds of copper.

Copper produced in 1912 from ores in which copper constitutes the principal value, by States.

State.	Copper ore.	Copper in ore.	Percentage.	Gold in ore.	Silver in ore.	Value in gold and silver per ton.
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
Alaska	93,452	29,230,491	15.63	7,428.08	376,593	$4.11
Arizona	6,542,154	359,407,265	2.75	57,507.81	2,378,593	.41
California	408,622	31,538,740	3.85	14,219.65	792,445	1.91
Colorado	13,718	1,622,605	5.91	8,759.83	224,327	23.13
Idaho	98,848	6,663,229	3.37	2,039.31	451,918	2.81
Michigan	11,411,941	218,138,408	.96	.00	528,453	.03
Montana	5,094,432	301,925,189	2.96	34,200.83	10,655,055	1.42
Nevada	3,276,169	85,579,530	1.31	23,511.60	173,545	.18
New Mexico	1,195,683	33,528,958	1.40	7,284.74	290,568	.275
North Carolina	500	75,915	7.59	43.86	523	2.25
Oregon	4,569	260,429	2.85	616.39	10,555	4.21
Pennsylvania and Maryland	225,200	594,022	.01	.00	502	.001
Tennessee	603,229	18,483,173	1.53	399.82	89,893	.105
Texas	22	721	1.64	.24	10	.50
Utah	6,670,845	127,712,169	.96	105,720.03	2,542,381	.56
Virginia	1,160	112,835	.98	.00	982	.52
Washington	15,715	1,054,805	3.35	134.31	230,883	9.21
Wyoming	155	27,570	8.89	.95	115	.59
Total and average	35,656,414	1,215,956,054	1.71	261,867.45	18,747,341	.47

Copper ores concentrated and smelted, concentrates produced, and copper produced from each class of ore in 1912, by States.

State.	Ore concentrated.				Ore smelted.		
	Quantity.	Concentrates produced.	Copper in concentrates.	Percentage of copper from ore.	Quantity.	Copper produced.	Percentage of copper from ore.
	Short tons.	*Short tons.*	*Pounds.*		*Short tons.*	*Pounds.*	
Alaska					[a] 93,452	29,230,491	15.63
Arizona	4,435,225	400,134	135,506,918	1.53	2,106,929	223,900,347	5.31
California					408,622	31,538,740	3.85
Colorado					13,718	1,622,605	5.91
Idaho	16,141	842	342,702	1.06	82,707	6,320,527	3.82
Michigan	11,411,941	169,878	218,138,408	.96			
Montana	4,341,051	1,496,476	218,461,297	2.51	753,381	83,463,892	5.54
Nevada	2,986,087	329,585	64,999,310	1.09	290,082	20,580,220	3.55
New Mexico	1,121,575	67,675	28,702,749	1.28	74,108	4,826,209	3.26
North Carolina					500	75,915	7.59
Oregon					4,569	260,429	2.85
Pennsylvania and Maryland	224,200	6,950	584,422	.01	1,000	9,600	.48
Tennessee					603,229	18,483,173	1.53
Texas					22	721	1.64
Utah	6,098,491	261,941	102,711,717	.84	572,354	25,000,452	2.18
Virginia					1,160	112,835	.98
Washington	7,685	584	140,160	.91	8,030	914,645	5.69
Wyoming					155	27,570	8.89
Total and average	30,642,396	2,734,065	769,587,683	1.26	5,014,018	446,368,371	4.45

[a] Includes some ore concentrated.

Copper produced from copper-lead and copper-zinc ores in 1912, by States.

State.	Copper-lead and copper-zinc ores.	Copper in ore.	Percentage of copper.
	Short tons.	*Pounds.*	
Arizona	315	26,731	4.25
Colorado	6,810	531,227	3.90
Idaho	33	11,949	18.10
Montana	1,788	118,166	3.30
Nevada	168	11,031	3.28
New Mexico	398	40,308	5.06
Utah	5,102	355,779	3.48
Total and average	14,614	1,095,191	3.75

Copper derived from ore classed as copper-bearing ores (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in 1912, by States.

State.	Ore treated.	Copper recovered.	Percentage of copper.	Copper from all sources, including old slags, smelter cleanings, precipitates, etc.
	Short tons.	*Pounds.*		*Pounds.*
Alaska	93,452	29,230,491	15.63	29,230,491
Arizona	6,542,469	359,433,996	2.75	[a] 365,038,649
California	408,622	31,538,740	3.85	33,451,672
Colorado	20,528	2,153,832	5.24	[b] 7,107,303
Idaho	98,881	6,675,178	3.38	7,492,152
Michigan	11,411,941	218,138,408	.96	218,138,408
Missouri				[c] 440,725
Montana	5,096,220	302,043,355	2.96	[d] 309,738,873
Nevada	3,276,337	85,590,561	1.31	[e] 86,477,494
New Mexico	1,196,081	33,569,266	1.40	34,030,964
North Carolina	500	75,915	7.59	75,915
Oregon	4,569	260,429	2.85	260,429
Pennsylvania and Maryland	225,200	594,022	.01	594,022
Tennessee	603,229	18,483,173	1.53	18,483,173
Texas	22	721	1.64	721
Utah	6,675,947	128,067,948	.96	[f] 137,307,485
Virginia	1,160	112,835	.98	112,835
Washington	15,715	1,054,805	3.35	1,086,010
Wyoming	155	27,570	8.89	27,570
Total and average	35,671,028	1,217,051,245	1.70	1,249,094,891

[a] Considerable copper was recovered from old slags and ores not classed as copper ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Recovered in dressing lead ores.
[d] A large amount of copper was recovered as precipitates from mine waters and from ores not classed as copper ores.
[e] Considerable copper was recovered from siliceous and other ores.
[f] A large amount of copper was derived from ores classed as lead ores, lead-zinc ores, and siliceous ores.

Copper ores produced in the United States, 1906–1912, by years, in short tons, and average yield in copper, gold, and silver.

Year.	Copper ores.	Yield in copper.	Yield per ton in gold.	Yield per ton in silver.	Value per ton in gold and silver.
	Short tons.	*Per cent.*	*Ounces.*	*Ounces.*	
1906	18,000,000	2.50	0.0150	0.882	$0.856
1907	20,253,000	2.11	.0135	.609	.682
1908	22,290,886	2.07	.0104	.666	.560
1909	27,932,618	1.98	.0097	.655	.540
1910	28,497,238	1.88	.0093	.562	.495
1911	29,988,235	1.82	.0089	.555	.492
1912	35,656,414	1.71	.0073	.517	.468

Copper ores produced in the United States, 1906–1912, by years, classified as smelting and concentrating ores, in short tons, and average yield in copper from each.

Year.	Smelting ores.		Concentrating ores.	
	Quantity.	Yield in copper	Quantity.	Yield in copper.
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*
1906	3,278,000	.....	14,722,000	.....
1907	3,957,500	4.05	16,295,500	1.41
1908	4,665,534	4.27	17,760,522	1.485
1909	5,267,707	4.15	22,664,911	1.47
1910	5,001,394	4.14	23,495,844	1.40
1911	4,355,650	4.66	25,632,585	1.34
1912	5,014,018	4.45	30,642,396	1.26

TONNAGE.

The output of copper, copper-lead, and copper-zinc ores mined in 1912 was 35,671,028 tons, as compared with 29,994,942 tons in 1911. Of this output 35,656,414 tons were copper ores and 14,614 tons were copper-lead and copper-zinc ores, as compared with 29,988,235 tons of copper ores and 6,923 tons of copper-lead and copper-zinc ores in 1911. Of the 35,656,414 tons of copper ores, 5,014,018 tons were smelting ores and 30,642,396 tons were concentrating ores, as compared with 4,355,650 tons of smelting ores and 25,632,585 tons of concentrating ores in 1911.

In 1912 concentrating ores produced 2,734,065 tons of concentrates, the average concentration being 11.14 into 1, as compared with 11.6 into 1 in 1911 and with 11.3 into 1 in 1910. Excluding the ores and concentrates from Michigan, 19,230,455 tons of ore produced 2,564,187 tons of concentrates, or a concentration of about 7.50 into 1, as compared with 7.2 into 1 for 1911.

It is seen by reference to the tables showing the production of ores for the last seven years that there has been an increase of over 97 per cent in the tonnage mined since 1906. The actual increase has been most in concentrating ores. The output of smelting ores has increased about 53 per cent and that of concentrating ores has increased about 107 per cent. Michigan, with 11,411,941 tons, was by far the largest producer of copper ores in 1912, and was followed in order by Utah, Arizona, Montana, Nevada, New Mexico, Tennessee, and California. In the output of smelting ores the States were in the following order: Arizona, Montana, Tennessee, Utah, and California; in the output of concentrating ores Michigan was first, followed in order by Utah, Montana, Arizona, Nevada, and New Mexico.

YIELD.

The 35,671,028 tons of copper, copper-lead, and copper-zinc ores mined in 1912 contained 1,217,051,245 pounds of recoverable copper, or an average of 1.70 per cent, as compared with 1.826 per cent for 1911, and with 1.88 per cent for 1910. If the Michigan output is excluded, the yield of the remaining copper ores was 2.06 per cent in 1912, as compared with 2.30 per cent in 1911 and with 2.41 per cent in 1910.

In 1912 a total of 35,656,414 tons of copper ores produced 1,215,956,054 pounds of copper, or an average yield of 1.71 per cent

copper, and 14,614 tons of copper-lead and copper-zinc ores produced 1,095,191 pounds, or an average yield of 3.75 per cent copper. The 5,014,018 tons of smelting ore yielded 446,368,371 pounds of copper, or an average of 4.45 per cent, as compared with 4.66 per cent for 1911 and with 4.14 per cent for 1910.

The 30,642,396 tons of concentrating ore yielded 769,587,683 pounds of copper, or an average of 1.26 per cent, as compared with 1.34 per cent for 1911 and with 1.40 per cent for 1910. Excluding the ores from Michigan, which yielded an average of 0.96 per cent in 1912, the concentrating ores from the remainder of the United States yielded an average of 1.41 per cent, as compared with 1.59 per cent in 1911 and with 1.73 per cent in 1910.

As shown in the table giving yield in copper, gold, and silver, there has been a marked decrease in the tenor of copper ores treated during the last seven years, the average yield dropping from 2.50 per cent in 1906 to 1.71 per cent in 1912. The average yield of the smelting and the concentrating ores, considered separately, shows less change, the decrease in the average of total ores being due in part to a relative increase in the tonnage of concentrating ores.

Of the important copper-producing States Alaska yielded the highest grade of ore in 1912, the average yield being 15.63 per cent copper; California was second, with 3.85 per cent; Montana was third, with 2.96 per cent; Arizona was fourth, with 2.82 per cent; and Tennessee, Nevada, and Utah followed in the order named.

Of the States producing an important quantity of smelting ore Alaska had the highest yield with 15.63 per cent, followed by Montana with 5.54 per cent, Arizona with 5.31 per cent, California with 3.85 per cent, and Utah and Tennessee with 2.18 and 1.53 per cent, respectively.

In the yield from concentrating ores Montana took first rank with an average of 2.51 per cent, followed by Arizona, with 1.59 per cent; New Mexico, 1.28 per cent; Nevada, 1.09 per cent; Michigan, 0.96 per cent; and Utah, 0.84 per cent.

Since 1908 the average recovery from concentrating ores has decreased from 1.48 per cent to 1.26 per cent.

In 1912 copper ores yielded 261,867.45 ounces of gold and 18,424,551 ounces of silver, or an average of 0.0073 ounce of gold and 0.517 ounce of silver per ton. The total value of the gold and silver content of copper ores was $16,744,379, an average precious-metal value of 46.8 cents per ton. In 1911 copper ores yielded 0.0089 ounce of gold and 0.555 ounce of silver per ton, an average precious-metal value of 49.2 cents per ton. Exclusive of that portion of the Michigan ores from which the silver was not recovered, the average precious-metal content in 1912 was 62 cents per ton of ore, as compared with 67 cents in 1911 and with 74 cents in 1910.

Exclusive of the Michigan ores that did not yield silver, there was still included considerable ore from which the gold and silver values were not recovered, namely, that producing the casting copper from the Morenci Metcalf district, Arizona, and from the Ducktown district, Tennessee, and to a slight extent from other districts. This casting copper was not electrolytically refined, and consequently the precious-metal values were not recovered from it.

Among the important copper-producing States Alaska was first in the yield in gold and silver per ton of copper ore, the average being

$4.11; California was second, with $1.91 per ton; Montana third, with $1.42 per ton; Utah, with $0.50; Arizona, $0.41; New Mexico, $0.27; Nevada, $0.18; Tennessee, $0.105; and Michigan, $0.03.

REVIEW BY STATES.

INTRODUCTORY STATEMENT.

In the following pages a brief statement of the conditions affecting production in the principal districts of the country is presented, the geologic occurrence of the ores is briefly summarized, and the tenor of ore from each district is given when this will not disclose the production of individual companies, the figures of whose output have not already been published in their annual report or elsewhere.

Those desiring more detailed information of the mining operations of the districts are referred to the reports on mine production for the various States, which are published by the United States Geological Survey and which, with this and other reports, form the first part of the volume Mineral Resources of the United States for 1912, as shown in the prefatory note.

The report for 1910 contained a map showing the location of the principal copper-producing districts of the United States and the location of the principal reduction plants. The map has not been reproduced in this report, but copies can be obtained on application to the Director of the United States Geological Survey.

Where figures of metal output, ore reserves, recovery in treatment, etc., of individual companies are given in this report, unless otherwise stated, it is to be understood that they are quoted from the official report of the company.

ALASKA.

The production of blister copper from Alaska in 1912 was 31,926,209 pounds, as compared with 22,314,889 pounds in 1911. The increase in the output for 1912 is due to the larger production from the Copper River and Prince William Sound districts. The mine production of copper for 1912 was 29,230,491 pounds, the larger smelter production resulting from the treatment of some ore mined the previous year.

Important productions of copper from Alaska began about 1903, since which time it has been a steady contributor of that metal. To the close of 1912 the total production of blister copper has been 91,052,543 pounds. The output for 1912 was from the Ketchikan, Prince William Sound, and Copper River districts.

Ketchikan district.—Production in the Ketchikan district was again small in 1912, being hardly more than that for 1911, which was the smallest in several years. The deposits of the district[1] thus far developed are of contact origin, the ores run high in iron, being composed of pyrrhotite, magnetite, pyrite, and chalcopyrite, and are a desirable ore for the British Columbia and Washington smelters. The ores were shipped to the Tacoma smelter. Only the relatively high-grade ores are shipped, as the low-grade material can not be marketed profitably. The average yield in copper is between 4 and 5 per cent, and the ores carry rather low values in gold and silver.

Prince William Sound district.—Copper mining in the Prince William Sound district was active, the output being one of the largest

[1] For detailed descriptions see Wright, C. W., and Paige, Sidney, Mineral resources of Alaska in 1907: Bull. U. S. Geol. Survey No. 345, 1908, pp. 98–115; and Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908.

made by this district. The ores of the district were shipped to the Tacoma smelter. The deposits [1] consist of pyrrhotite, chalcopyrite, and pyrite, with minor amounts of other sulphides occurring in shear zones in or closely associated with greenstone. The largest producer was the Beatson Bonanza mine, though the Ellamar mine was an important producer, and others also contributed. Other copper properties were being developed.

Copper River district.—The Kennicott-Bonanza mine was the only producer in the Copper River district. The concentrating plant installed at this mine in 1911 was put in operation during 1912. Development of other properties was active during the year.

The primary ores [2] of the Bonanza mine are principally chalcocite with some bornite, replacing limestone near a greenstone contact. These minerals have been to slight extent altered to carbonates at the surface. This is one of the few important copper deposits known in which chalcocite, the principal ore mineral, is regarded as a primary mineral. Much of the ore is almost pure chalcocite and is very high grade, while the lower grade ore with a limestone gangue is susceptible of high concentration.

ARIZONA.

In 1912 Arizona produced 359,322,096 pounds of blister copper as compared with 303,202,532 pounds in 1911. This is the largest output in the history of the State, or of any State, and continues Arizona in first place among the copper-producing States.

The steady output of copper from Arizona began about 1875, though there was intermittent production prior to that date, the earliest record of production being for 1862. Since 1880 the growth of the industry has been steady and rapid. To the close of 1912 Arizona had a recorded production of 3,853,655,207 pounds of copper, or 21.86 per cent of the total output of the country, thus ranking third among the States in total production. Arizona produced 28.90 per cent of the total output of the country for 1912.

Eleven copper-smelting plants were operated within the State during the year.

The greater part of the production was from five districts.

Bisbee district.—The Bisbee or Warren district, in southern Cochise County, was the largest producer, with about 140,000,000 pounds of blister copper, as compared with 130,200,000 pounds in 1911. Production in the district began in 1880, since which time it has been a constant and increasingly important contributor to the output of copper. To the close of 1912 it had produced 1,555,200,000 pounds of copper, or 11.26 per cent of the output of the country and 40.3 per cent of the Arizona production. In total and in present output it ranks third among the copper districts of the country.

The oldest rocks [3] in the Bisbee district, according to Ransome, are the pre-Cambrian Pinal schist, which has been intruded by

[1] Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: Bull. U. S. Geol. Survey No. 443, 1910, pp. 87–96.

[2] Moffit, F. H., and Maddren, A. G., Mineral resources of the Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909.

[3] For detailed geologic report, see Ransome, F. L., Geology and ore deposits of the Bisbee quadrangle, Arizona: Prof. Paper U. S. Geol. Survey No. 21, 1904. Rice, C. T., Camp of Bisbee, Arizona: Mines and Methods, Salt Lake City, Utah, vol. 1, 1909, p. 241. Weed, W. H., Is geology a success as a guide to ore deposits: Min. and Eng. World, vol. 27, p. 245. Douglas, James, Notman, Arthur, Legrand, Charles, and Lee, George B., The Copper Queen mines and works, Arizona, U. S. A.: Bull. Inst. Min. and Met. No. 101; Eng. and Min. Jour., March 8, 1913. Ransome, F. L., Notes on the Bisbee district, Arizona: Bull. U. S. Geol. Survey No. 529, 1913, pp. 179–182.

granite, probably also of pre-Cambrian age. On this basement were deposited upwards of 5,000 feet of Paleozoic sediments consisting for the most part of limestone with quartzite at the base. These beds were intruded in early Mesozoic time by stocks, dikes, and sills of granite porphyry. After a period of erosion Cretaceous sediments were deposited on the earlier formations, which have since been largely removed from the producing area.

The primary ores were deposited during and after the intrusion of the granite porphyry and were genetically connected with that intrusion. The presence of garnet, tremolite, diopside, and other silicates associated with the ore minerals indicates a contact origin of the deposits.

The principal ore bodies occur around the porphyry stock of Sacramento Hill and along faults and fissures where the ore minerals have replaced the limestone. The most important ore bodies thus far developed have been in the Carboniferous and Devonian limestones, but in recent years important deposits have been discovered in the Cambrian limestone and ore has also been developed in the granite porphyry.

In the northern part of the district the ore deposits are frequently closely associated with porphyry bodies and this association serves to some extent as a guide in prospecting, but in the southern end of the district porphyry intrusions are less abundant and the ore bodies occur associated with fissures.

The primary ores of the district consist mainly of pyrite and chalcopyrite with smaller bodies of galena and some sphalerite. Alteration by surface solutions has extended to great depth and a large part of the ore extracted has been oxidized ore and secondarily enriched sulphide ore. In recent years, however, there has been developed large bodies of primary sulphides of commercial grade. Most of the ore of the district occurs in irregular bodies without very definite arrangement and the cost of prospecting is consequently rather high. The irregular character of the ore deposits and the heavy ground, especially in the oxidized ore bodies, has resulted in relatively high cost of extraction. Recently, however, modifications in the system of mining have resulted in a decrease in the timber used per ton of ore and also in the cost of extraction. The cost of mining will, however, doubtless remain relatively high as compared with districts where cheaper systems of mining can be safely and economically employed.

The principal companies of the district report material increase in the ore reserves. It is not the policy, however, to develop large reserves in advance of extraction since the cost of maintaining openings in much of the ground for long periods is prohibitive.

Some of the more important developments during the year were on the 1,250 and 1,300-foot levels of the Oliver shaft where important bodies of sulphide ore were developed. On the 1,300-foot level of the Briggs shaft large bodies of ore were developed and the exploration of the oxidized ore body on the 1,400-foot level of the Hoatson shaft showed that it extended nearly to the 1,500-foot level.

Systematic development by the Copper Queen Co. in the hitherto little-explored "porphyries," both by underground methods and by surface drilling, has indicated a promising field of future exploration and has already added greatly to the ore reserves.

The development of important bodies of ore is reported by the Shattuck Arizona Co.

The ores mined in the district continue to show a decrease in grade, but this is in part due to improvement in mining and metallurgical methods which permit the treatment of lower grade material. It is the policy of most of the companies to mine as low-grade ore as can be treated at a reasonable profit. For 1912 the average recovery was about 5.6 per cent copper, with 0.0318 ounce gold and 1.23 ounces silver per ton, an average precious metal value of $1.41 per ton of ore.

The following table shows the production of the Copper Queen mine:

Production of the Copper Queen Consolidated Mining Co. in 1912.

	Dry weight.	Gold.	Silver.	Copper.	Lead.
Shipped to Douglas:	*Short tons.*	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*
Ore mined	669,399	13,520	656,838	81,422,404	.....
Precipitates	998	.....	285	1,036,735	.....
Old dump slag	64,480	.....	5,725	2,966,797	.....
Old smelter cleanings	290	2	160	30,519	.....
Lessees' ore	9,411	612	36,535	2,074,825	.....
Shipped to El Paso:					
Lessees' ore	10,161	3,863	308,822	24,246	2,331,350
Company ore	1,465	26	18,140	6,188	622,335
Shipped to Globe: Sulphide ore	30,164	.....	625	719,194	.....
Total	786,368	18,023	1,027,130	88,280,908	2,953,685

The Calumet & Arizona Mining Co. and the Superior & Pittsburg Mining Co. produced a total of 53,108,628 pounds of refined copper, 594,319 ounces silver, and 22,881 ounces gold.

The following tables show the production and yield of ores by these companies in 1912:

Production of the Calumet & Arizona Mining Co. in 1912.

	Wet.	Dry.
Tons ore mined (including fluxing ore)	191,063	179,788
Tons ore shipped (including fluxing ore) to smelters	187,222	176,049
Tons ore smelter (not including fluxing ore)	169,287	159,513
Tons fluxing ore smelted	18,471	17,054
Pounds copper recovered per ton ore	86.81	92.129
Pounds copper recovered per ton fluxing ore	14.13	15.300
Per cent copper recovered per ton ore	4.340	4.606
Per cent copper recovered per ton fluxing ore	.756	.765
Average per cent regular ores (dry assay)	.....	5.077
Average per cent fluxing ores (dry assay)	.....	1.231

Production of Superior & Pittsburg Mining Co. in 1912.

	Wet.	Dry.
Tons ore mined	323,068	292,874
Tons ore shipped to smelter	318,899	288,845
Tons ore smelted	318,418	288,429
Pounds copper recovered per ton	115.251	127.234
Per cent copper recovered	5.762	6.361

For the fiscal year ending July 31, 1912, the Shattuck Arizona Copper Co. shipped 3,094 wet tons of ore with an average of 20.85 per

cent copper. From this there was recovered 1,253,305 pounds of copper, 21,008 ounces of silver, and 13 ounces of gold.

At Douglas the smelting plants of both the Copper Queen and the Calumet & Arizona companies were operated throughout the year. The reverberatory plant of the Copper Queen smelter was placed in operation and in the converting department the change from acid to basic lined converters was nearly completed. In addition to Copper Queen ores there were treated at this plant the concentrates from the Montezuma Copper Co. and custom ores.

The new smelting plant of the Calumet & Arizona Co. was in process of construction during the year and will be ready for operation in the latter part of 1913. The plant consists of receiving bins; crushing and sampling plant; bedding and conveyor system; roasting plant; two 48-inch by 40-foot blast furnaces; four reverberatory furnaces 19 by 100 feet, with foundation for a fifth furnace; stands for six Great Falls type converters.

The reverberatory furnaces will be equipped for the use of oil as fuel. The Calumet & Arizona Co. has a contract with the Shattuck Arizona Co. for the smelting of the ores from that mine.

The district is served by the El Paso & Southwestern Railroad. Oil for fuel is used extensively in the production of power, which is generated in central plants and distributed to the points where needed.

Morenci-Metcalf district.—The deposits of the Morenci-Metcalf district are at Morenci and Metcalf, in Greenlee County. During 1912 the district produced 79,900,000 pounds of blister copper, as compared with about 71,500,000 pounds in 1911.

The district was one of the earliest copper producers in the State, the output beginning as early as 1873, and since 1880 it has been an important contributor to the copper output of the country. To the close of 1912 a total of 1,034,100,000 pounds of copper had been produced, or 5.87 per cent of the output of the country since 1845, and 26.8 per cent of the output of the State. In total production it ranks fourth among the copper districts of the country and second in the State; in the output for 1912 it ranks fifth in the country and second in the State.

The copper ores[1] of this district occur as contact deposits in Paleozoic limestones and shales which have been intruded by stocks and dikes of porphyry, as disseminated deposits mainly in the porphyry, and as deposits in fault fissures of the Coronado type.

The original ores were pyrite and chalcopyrite of too low grade to be of economic importance. The workable bodies have resulted from the process of secondary enrichment. The ore bodies in the limestone were formed in certain beds favorable to deposition, and this produced roughly tabular bodies nearly parallel to the stratification of the limestone. Alteration of these bodies has produced oxidized ores which formed most of the workable ores in the limestone. These are now nearly exhausted.

The disseminated ores occur in highly altered porphyry adjacent to fissure veins. The copper content of the upper portion of these deposits has been leached and deposited as chalcocite on the pyrite

[1] For detailed report of the Clifton-Morenci district see Lindgren, Waldemar, The copper deposits of the Clifton-Morenci district, Arizona: Prof. Paper U. S. Geol. Survey No. 43, 1905. Tovote, W. L., Min. and Sci. Press, vol. 101, 1910, p. 770.

lower down. This has produced a zone of commercial ore varying in thickness, in general not extending below a depth of 400 feet.

In the fault fissure or Coronado type of deposit commercial ore has been developed to much greater depth, and recent exploration of the principal faults in Copper Mountain has shown that commercial ore occurs associated with these faults considerably below the general level of the ore zone.

Of the 1912 mine production of copper 58,539,890 pounds were derived from concentrating ores and 17,751,722 pounds from smelting ores. The mines of the district produced 1,510,093 tons of concentrating ores, yielding 1.94 per cent copper, and 216,482 tons of smelting ore yielding an average of 4.1 per cent copper, the average yield for the 1,726,575 tons of ore produced in the district being 2.21 per cent.

The ores in general carry low gold and silver values, and as much of the copper is of sufficient purity for commercial purposes it is not refined electrolytically, and consequently the precious metal content is not recovered.

Modified systems of slicing and caving ore now very largely employed in the extraction of ore and the amount of timber required has thus been very materially reduced from what it was when the square set method prevailed.

The following table gives a summary of the production of the mines of the Detroit Copper Co. for 1912:

Ore production of the Detroit Copper Co., Arizona, in 1912, in short tons.

Concentrating ore	501,451
Smelting ore	4,535
Quartz ore converter lining	11,342
Talc converter lining	441
Fine ore converter lining	208
Lease ore:	
Miscellaneous	1,102
Summit claims	115
Santa Rosa claims	367
Copper precipitate	70
Native copper	1
Total for year	519,632

The following table shows the result of concentrating operations of the Detroit Copper Co. during 1912:

Result of concentrating operations of the Detroit Copper Co. during 1912.

	Percentage of copper.
Ore concentrated (501,928 tons)	3.08
Concentrates produced (70,438 tons)	16.69
Savings:	
Ore and concentrates	76.12
Ore and tailings	77.34
Concentrates and tailings	77.06
Assays only	77.43
Tailings assay	.81
Tons ore milled per ton concentrates	7.1

The smelter treated 160,649.4 tons of charge comprising ore, concentrates, flux, and secondaries. Of this 75,783.3 tons consisted of ore and concentrates. This yielded 24,802,789 pounds of copper, the recovery in smelting being 93.86 per cent of the metal content.

During the fiscal year ending September 30, 1912, the Arizona Copper Co. (Ltd.) produced 38,132,000 pounds of copper. The company's mines produced 927,116 dry tons. The average yield in copper per ton of ore treated was 41.15 pounds, or 2.057 per cent. This compares with a yield of 2.32 per cent for the preceding year. Of the total ores, 96 per cent were concentrating ores and 4 per cent smelting ores. Of the total copper production, 84.5 per cent was derived from sulphide ores and 15.5 per cent from oxidized ores. During the latter part of the year plans were inaugurated for the construction of a new smelting plant to replace the present one, which has become out of date.

In the sulphide concentrators 782,100 tons of ore were treated, and 108,230 tons in the oxide concentrator. Tailings amounting to 89,890 tons were treated in the leacher. The ores treated in the oxide concentrator and leacher yielded 9.71 per cent of the output of copper. The sulphuric acid plant supplied to the leacher 3,998 tons of acid. The construction of the new smelting plant was in progress during the year and it will be ready for operation in 1913.

Production by the Shannon Copper Co. for the year ending August 31, 1912, was, copper, 16,406,336 pounds; gold, 2,615.027 ounces; silver, 170,690 ounces. During the same period the company mines produced 285,210 tons of ore.

Jerome district.—The Jerome or Verde district of Yavapai County produced about 31,680,000 pounds of blister copper in 1912, as compared with about 33,200,000 pounds in 1911. The production of copper in the district began about 1883, though it had yielded gold and silver previous to that time. Since 1888 it has been a steady and important producer.

To the close of 1912 it has yielded a total of 634,880,000 pounds of copper, or 3.60 per cent of the total output of the country since 1845, and 16.4 per cent of the total output of the State. In total output it stands sixth among the copper districts of the country and third in Arizona. In output for 1912 the district ranks ninth among those of the country and fifth in the State.

The rocks[1] in which the United Verde deposit occurs are pre-Cambrian schistose rocks resulting from the metamorphism of dioritic, rhyolitic, and possibly sedimentary rocks. The material most favorable to replacement by ore is a fissile sericitic schist.

According to Ransome:

> The ore shoot as a whole is of oval plan, its total horizontal length being about 1,300 feet and its greatest width 700 feet. Its general trend is north-northwest and it pitches in that direction at an angle of 45°. It has been worked to a vertical depth of 1,200 feet with no sign of approaching exhaustion. This great shoot is in reality a complex of smaller but nevertheless large irregular or lenticular ore bodies, apparently related in part to cross fissuring but showing a general tendency toward parallelism with the schistosity.
>
> The important ore constituent is chalcopyrite, associated with varying proportions of pyrite and sphalerite. Bornite has been reported but was not noted in 1912. Neither galena nor pyrrhotite was observed at the time of visit. The sulphides occur partly in small irregular fractures and along planes of schistosity, but to a large extent they have metasomatically replaced the schist, particularly the fine-grained sericitic variety. The ore contains very little vein quartz or other gangue mineral.
>
> The sulphides mentioned are primary and were deposited in pre-Cambrian time.

[1] Graton, L. C., Mineral Resources U. S. for 1907, pt. 1, U. S. Geol. Survey, 1908, p. 597; Ransome, F. L., Bull. U. S. Geol. Survey No. 529, 1913, p. 192.

The ores differ from most of the large copper deposits of Arizona in carrying rather high gold and silver values. The copper content of the ore is also unusually high for this type of deposit.

As little timber as possible is employed in mining on account of the danger from fire.

Considerable copper is recovered by precipitation on scrap iron from the mine waters that have leached through the burning stopes.

The ore is smelted at the United Verde Copper Co.'s plant.

The United Verde Copper Co. was the only important producer during the year. This company has a new smelting plant in process of construction.[1]

Development was carried on by other companies in the district during the year, but no important production was made. The district is served by a narrow-gage railroad owned by the United Verde Copper Co., which connects with the Santa Fe, Prescott & Phoenix Railway.

Globe district.—The Globe district of Gila County produced about 61,600,000 pounds of blister copper in 1912, as compared with about 44,600,000 pounds in 1911. The increase in production was largely due to increased output by the Miami Copper Co. The mine production for the year exceeded the smelter production, as some material had not been smelted at the close of the year.

Production of copper began in the district about 1881; the camp was well known as a silver producer before that date. For several years subsequent to 1881 the production was intermittent, but since 1888, and especially since 1898, when the railroad reached the camp, the district has ranked among the important copper producers of the country. To the close of 1912 it has produced a total of 440,900,000 pounds of copper, or 2.50 per cent of the output of the country since 1845, and 14.4 per cent of the output of the State. In total production the district ranks seventh in the country and third in the State; for 1912 it ranks seventh in the country and third in the State. Important production began in the Miami section in 1911 and this section of the district will continue to grow in importance.

The geology [2] of the district may be briefly summarized as follows: Paleozoic sediments, consisting of conglomerates, quartzites, shales, and limestones were laid down unconformably on a pre-Cambrian basement of schist and intruded granitic rocks. In post-Paleozoic time the region was invaded by an intrusion of diabase followed by an intrusion of granitic rock. After a period of erosion the area was partly or wholly buried beneath Tertiary volcanic and sedimentary rocks which have since been partly removed by erosion.

The copper deposits are believed to have been introduced at the time of or closely following the post-Paleozoic granitic intrusion, and the source of the copper-bearing solutions is believed to have been connected with this igneous rock. The deposits of the district are of quite different types, dependent largely upon the nature of the rocks in which they were formed. In the Globe end of the dis-

[1] The new plant is described by Vail, R. H., Eng. and Min. Jour., vol. 96, pp. 287–292.

[2] For detailed description, see Ransome, F. L., Geology of the Globe copper district, Arizona: Prof. Paper U. S. Geol. Survey No. 12, 1903; Geology at Globe, Ariz.: Min. and Sci. Press, vol. 100, 1910, p. 256; Geology of the Globe district, Ariz.: Idem, vol. 102, 1911, p. 747. Tolman, C. F., jr., Min. and Sci. Press, vol. 99, 1909, p. 646. Higgins, Edwin, Eng. and Min. Jour., vol. 89, 1910, pp. 769, 813, 870. Ransome, F. L., Bull. U. S. Geol. Survey No. 529, 1913, pp. 183–186.

trict the deposits occur as roughly lenticular deposits replacing limestone, and as fault lodes or fissure zones of quartz and sulphide in diabase.

In the Miami end of the district the ores occur mainly as small veins of quartz and sulphide in the shattered rock near the granite schist contact, the mineralization occurring in both formations.

In the Globe section of the district most of the ores developed to the present time owe their commercial value to enrichment. The ore extracted from the limestone has been largely oxidized, and much of the ore developed in the diabase has been enriched sulphide. Under favorable conditions the sulphide enrichment has gone on to the greatest depth to which development has extended. Some bodies of primary ore of commercial grade have also been developed.

In the disseminated bodies of the Miami section the original ore was sulphides of iron and copper. The copper content of the ores near the surface has been partly taken into solution and redeposited as chalcocite on the sulphides lower down. The commercial ore consists of grains of pyrite and chalcopyrite partly or wholly replaced by chalcocite. The commercial bodies of ore are blanket-like deposits overlain by leached "capping" and underlain by primary material too lean in copper content to be classed as commercial ore.

In places overlying the sulphide ore there is a considerable quantity of oxidized and partly oxidized ore of a grade that would permit of extraction if a satisfactory method of recovering the metal were available.

An exceptional type of ore is that of the Black Warrior mine, which is oxidized ore cementing dacite tuff or breccia.

The ores in the Globe end of the district vary greatly in copper content, the grade to be treated at any given time depending largely on the possibility of profitable treatment. In general ores of as low grade as can be handled with reasonable profit are mined. During 1912 the ores of the entire district yielded about 2.21 per cent of copper, with about 14 cents in gold and silver per ton. The mines of the district produced 1,210,366 tons of concentrating ore yielding an average of 1.68 per cent copper and 179,711 tons of smelting ore yielding an average of about 5.75 per cent copper.

The Old Dominion smelter was the only reduction plant operating in the district during the year.

The district is served by the Arizona Eastern Railroad.

The Old Dominion and the United Globe mines at Globe and the Miami mine at Miami were the largest producers during the year. The ore produced by the Old Dominion Co. is shown below.

Ore produced by Old Dominion Co., Arizona, in 1912.

	Short tons.	Percentage of copper.
Smelting ore	93,592	6.43
Concentrating ore	106,232	3.15
Silica lining	1,357	2.70
Total	201,181	4.67

The ores of the Old Dominion mine yielded 16,533,999 pounds of copper, 42,750.73 ounces silver, and 583.378 ounces gold.

The average cost of refined copper for the year was 10.34 cents per pound.

The United Globe Co. produced 188,254 tons of ore and slag yielding 12,252,073 pounds of copper, 124,362 ounces of silver, and 789.47 ounces of gold.

The Miami Copper Co. treated 1,041,769 tons of ore from its mine and stock pile.

The following table shows the results of milling operations:

Milling operations of Miami Copper Co., Arizona, in 1912.

Ore milled	short tons	1,040,744
Percentage of copper in ore		2.393
Concentrates produced	tons	46,683
Percentage of copper in concentrates		37.020
Copper in concentrates	pounds	34,560,665
Copper recovered per ton of ore	do	33.21
Mill extraction	per cent	69.39

The net smelter returns of refined copper from concentrates amounted to 32,832,607 pounds. Based on the net production, the cost of copper in concentrates on board cars at Miami was as follows:

Cost of copper f. o. b. cars at Miami in 1912.

	Per ton of ore.	Per pound of copper.
Mining	$1.20315	$0.03813
Milling	.65861	.02087
General	.18023	.00577
Total	2.04199	.06477

The total cost of producing and marketing copper for the year was 9.5884 cents per pound.

On January 1, 1913, the ore reserves were estimated as 20,800,000 tons with an average copper content of about 2.48 per cent. In addition there is developed 17,200,000 tons of material averaging 1.21 per cent copper. This material at present is not regarded as commercial ore but may be at some future time.

In 1912 the Inspiration Consolidated Copper Co. was formed as a merger of the Inspiration Copper Co. and the Live Oak Copper Co. During 1912 operations at the mine were largely confined to preparing the mines for the extraction of ore. The ore reserves remain essentially as at the beginning of the year, namely, about 45,000,000 tons with an average copper content of about 2 per cent.

Plans were made for the construction of a concentrator with a daily capacity of 7,500 tons. Late in the year tests of a flotation process of concentration were made in a 50-ton plant installed by the Minerals Separation Co. This proved so successful that it was announced that a 600-ton unit would be constructed for the testing of this process on a large scale before the construction of the mill on the original plans was carried out.

Development work was carried on by other companies in the district.

Mineral Creek or Ray district.—The Mineral Creek or Ray district began important production during 1911. The output for the year

was about 15,700,000 pounds. This was the first important production of copper from this district. In 1912 the district produced about 34,600,000 pounds of copper, making a total production of about 50,300,000 pounds to the close of 1912. The geology[1] of the district is very similar to that of the Globe district to the north. Paleozoic sediments have been deposited on a basement of pre-Cambrian schists. In post-Carboniferous time the region was invaded by an intrusion of diabase and later by a granitic intrusive of varying composition. After a period of erosion the area was buried beneath Tertiary volcanic and sedimentary rocks. Later it was elevated, faulted, and the covering of Tertiary sediments partly removed. The ore deposits of the district are of two distinct types—those formed in the sedimentary rocks adjacent to faults and fissures, and the disseminated deposits in the schist and granite. The ores of both types are believed to have been introduced at the time of and closely following the granitic intrusion.

The deposits of the first type are found east of the Ray fault. The ores are mainly oxidized. To the present time important production has not been made from this type, nor have large ore reserves been developed.

The disseminated deposits occur in crushed schist and "granite." The original mineralization was pyrite and chalcopyrite, but the commercial ore has resulted from enrichment of the deposits produced by the leaching of the copper values from the upper portion and the redepositing them as chalcocite on the sulphides lower down. This has resulted in a blanket-like deposit of commercial ore covered by a relatively barren capping and underlain by a zone of original mineralization too low in copper content to be of commercial value.

The average thickness of the leached zone or "capping" in the Ray Consolidated ground is 252 feet, and the average thickness of the ore 101 feet. Locally, especially associated with the diabase, native copper becomes of some importance.

The district is served by the Arizona Eastern Railroad. The mines and reduction works are connected by the Ray & Gila Valley Railroad, controlled by the Ray Consolidated Copper Co.

During the year the Ray Consolidated Copper Co. acquired the property of the Ray Central Copper Co. There was little prospecting conducted during the year, the ore reserves remaining essentially as at the beginning of 1912. The total ore developed in the Ray Consolidated ground, including Ray Central, to the close of 1912, was 82,904,368 tons, averaging 2.19 per cent copper. The total tonnage mined from the beginning of operation to the close of 1912 was 2,247,395 tons, averaging 1.72 per cent copper. The total known tonnage remaining in the developed area at the close of 1912 was 80,656,973 tons, averaging 2.2 per cent copper.

A total of 1,565,875 tons of ore were concentrated at the mill, containing an average copper content of 1.677 per cent. The average recovery in concentrates for the year was 68.2783 per cent, corresponding to a recovery of 22.9 pounds of copper per ton of ore. The

[1] Ransome, F. L., Geology of the Globe district, Arizona: Min. and Sci. Press, vol. 102, 1911, p. 747. Weed, W. H., The Ray copper mining district, Arizona: Mining World, vol. 34, 1911, p. 53. Tolman, C. F., jr., Disseminated chalcocite deposits at Ray, Arizona: Min. and Sci. Press, vol. 99, 1909, p. 622. Clifford, Jas. O., Ray Consolidated properties: Mines and Methods, Salt Lake City, Utah, vol. 4, p. 83. Ransome, F. L., Bull. U. S. Geol. Survey No. 529, 1913, p. 186.

average grade of concentrates produced was 18.944 per cent copper. The production of copper in concentrates amounted to 35,861,496 pounds. The average cost per pound of copper after deducting smelting and refinery losses was 9.828 cents.

The smelting plant of the American Smelting & Refining Co. at Hayden was completed during the year and the concentrates from the Ray mill were smelted at that plant.

Silverbell district.—The Silverbell district of Pima County made but a small production of copper in 1912, as in the preceding year.

Important copper production began in the district in 1904, though it had produced some silver and a little copper before that date. At the close of 1912 the district had yielded about 41,800,000 pounds of copper.

Paleozoic sediments [1] have been intruded by an acid porphyry, the sedimentary formation for the most part being detached blocks entirely surrounded by porphyry. The copper deposits are of two types—contact deposits, in which the sulphides of iron and copper, together with contact silicates, garnet, epidote, etc., have replaced limestone; and disseminated deposits, in which the original ores consist of iron and copper sulphides as veinlets and small grains in the shattered porphyry. The commercial ores of the latter type in this district, as in most others, have resulted from the enrichment of these deposits.

The ore mined to the present time has been principally that of the contact deposits. These ores are in general rather low-grade smelting ores. However, they are nearly or quite self-fluxing and can be treated cheaply. Development of disseminated ores has been in progress by several companies and encouraging results are reported, but there has been no important output from this type of ore.

A branch of the Southern Pacific Railroad extends from Red Rock to the district.

The Imperial Copper Co. has been the main producer in the district.

Other districts.—Shipments of ore were continued for the Turquoise district, Pinal County, the output for the year being about 8,000,000 pounds of copper, the largest in the history of the camp. The Paleozoic sediments [2] of the district have been extensively faulted and intruded by monzonitic porphyries. The copper deposits of the district may be grouped as follows:

(1) Oxidized blanket deposits connected with thrust faulting, exemplified by the ore bodies of the Germania and Mary mines. (2) Pyritic deposits with some associated bodies of oxidized ore in the Cambrian dolomitic limestone and shale, exemplified by the Mame and Leadville mines. (3) Pyritic deposits with associated bodies of oxidized or enriched ore in Carboniferous limestone, exemplified by the Copper Belle and other mines near Gleeson.

Other districts making important production of copper were the Big Bug and Copper Basin districts of Yavapai County, the Palmetto district of Santa Cruz County, the Pima of Pima County, and the Pioneer district of Pinal County.[3]

[1] The district has been briefly described by Tolman, C. F., jr., Min. and Sci. Press, vol. 90, 1909, p. 710; and Stewart, C. A., Geology and ore deposits of the Silverbell mining district, Arizona: Bull. Am. Inst. Min. Eng. No. 65, May, 1912, pp. 455–501.

[2] Ransome, F. L., The Turquoise copper-mining district, Arizona: Bull. U. S. Geol. Survey No. 530, 1912, pp. 125–134.

[3] For description of the geology of the Pioneer district, see Ransome, F. L., Copper deposits near Superior, Ariz.: Bull. U. S. Geol. Survey No. 540–D, 1913.

CALIFORNIA.

In 1912 California produced 31,516,471 pounds of blister copper, as compared with 35,835,651 pounds in 1911. The reduction in output for the State for the last two years is due to the necessity of eliminating from the smelter smoke ingredients injurious to vegetation, which has resulted in the shutting down of all but one of the smelters in the Shasta County district.

California was among the earliest of the Western States to make an important output of copper. Production began in the "Foothill" belt about 1862 and for several years was an important industry, California being second only to Michigan in its copper production. In a few years, however, the industry declined, and California did not have important rank as a copper producer until 1897, when production from the Shasta County district began. Since that time there has been a steady and important output from the State. The production for the early years has been ascertained from the best sources available, and adding to this the known production since 1882, it is found that to the close of 1912 California has produced about 518,487,000 pounds of copper, or 2.94 per cent of the output of the country since 1845. In 1912 the output was 2.53 per cent of the total production of the United States. In total output the State ranks fifth among the copper producers and for 1912 it ranked seventh. Four plants in the State treated copper ores in 1912.

The main production has come from two districts, though numerous other districts have made small outputs, and copper minerals are widely distributed over the State. The largest producer has been the Shasta County district and the next most important the "Foothill" district.

Shasta district.—The Shasta County copper belt is situated in the Klamath Mountains, at the head of the Sacramento Valley, a few miles north of the town of Redding. Sacramento River crosses the belt, separating it into an eastern and a western portion, the eastern portion containing the Bully Hill and the Afterthought districts; and the western, the Iron Mountain and the Little Backbone districts. Placer mining was carried on in the district in the early days of mining in the State, and later considerable silver was produced from the gossan outcrop of the copper deposits. Although copper minerals have been long known from the district, it was not until 1897, when the Mountain Copper Co. (Ltd.) began production at Iron Mountain, that it became an important contributor of copper. In 1912 the district produced about 26,000,000 pounds of copper, as compared with about 29,900,000 pounds in 1911. The total production to the close of 1912 has been about 391,900,000 pounds, or about 2.22 per cent of the total output of the country. In 1912 the district produced about 2.09 per cent of the total output. In total output the district ranks eighth and in the production for 1912 it ranked tenth among the copper districts of the country.

The inclosing rock[1] of most of the ore bodies is an intrusive alaskite porphyry of Mesozoic age. The ore minerals have replaced this rock along zones of shearing. In the western district the ores thus

[1] Diller, J. S., Redding folio (No. 138), Geol. Atlas U. S., U. S. Geol. Survey, 1906; Bull. U. S. Geol. Survey No. 213, 1903, pp. 123–132; Bull. U. S. Geol. Survey No. 225, 1904, pp. 169–179. Graton, L. C., The occurrence of copper in Shasta County, Cal.: Bull. U. S. Geol. Survey No. 430, 1910, p. 71.

far developed are large flat-lying, more or less tabular bodies of no great vertical extent. In the eastern district thay have more the character of veins and locally form deposits in the adjoining sediments.

The ore in the western district is pyrite, with a small percentage of chalcopyrite and varying amounts of sphalerite. In the eastern district sphalerite becomes an important constituent.

Rich secondary sulphide ores were found underlying the gossan at Iron Mountain and Bully Hill, but these have been exhausted.

The ores carry values in precious metals, those of the eastern district being rich in them. The average metal content of the copper ores from the district for 1912 was 3.53 per cent of copper, with $1.84 per ton in precious metals.

The producing companies in 1912 were the Mountain Copper Co. and the Mammoth Copper Co. The ores of the Mammoth Co. were smelted at their plant at Kennett, and the Mountain Co.'s ores were smelted at their Martinez plant on San Francisco Bay.

In addition to local ores the smelters treated ores from Nevada, Idaho, and Oregon. A considerable tonnage of the low-grade gold quartz ores of the districts was used by the smelter as flux. The pyritic process of smelting is practiced successfully in the district.

The Mammoth smelter was the only reduction plant operated in the district during 1912. The company reports that the bag house is successfully removing the ingredients harmful to vegetation from the smelter fumes. Complaints by farmers of injury to vegetation were, however, made during the year.

A satisfactory process for the treatment of the material collected in the bag house to recover its metal content was not developed during the year but it is hoped that such a process will eventually be discovered.

The extraction of ore from the Mammoth mine amounted to 278,088 tons. A good portion of this tonnage was replaced by new ore found but the additions were not sufficient to maintain the ore reserves.

The Mountain Copper Co. treated 88,651 tons of ore during the year, including 9,995 tons Iron Mountain ore, 30,368 tons No. 8 mine ore, 46,007 tons Hornet mine ore, and 2,281 tons purchased ore. The copper produced was 2,667 tons.

At the close of the year the ore reserves were estimated as follows: Iron Mountain ore, 80,000 tons averaging 5.75 per cent copper; No. 8 mine, 245,000 tons averaging 4.50 per cent copper. In addition there is a large body of ore in the Hornet mine that is low grade in copper, but contains a high percentage of sulphur.

The Balaklala and Bully Hill smelters which were closed by order of the courts, on account of damage to vegetation, remained idle during the year. Experiments looking to a treatment of Bully Hill ores for the recovery of both zinc and copper and the elimination of objectionable fumes are reported to have been carried on and it is currently reported that an attempt to meet the requirements of the courts and reopen the Balaklala plant is to be made in 1913.

Electric power is used almost exclusively at both mines and smelters.

The district is served by the Southern Pacific Railroad, short branches extending to the smelters. The Iron Mountain district is

connected with the main line by a narrow-gage railroad operated by the Mountain Copper Co., and the mines of the Mammoth Co. are connected with the smelter by a combined electric railroad, gravity tram, and steam railroad. The ores of the Balaklala mine are delivered to the smelter over a cable tramway.

"Foothill" district.—The "foothill" belt is a rather extensive area of copper deposits which has its best development in Calaveras County. This belt furnished practically the entire copper production from California in the sixties. Following that period of activity, the district was inactive for many years. From 1887 to 1892 the mines made some production. The present period of activity began about 1901, and for some years the district has made important contributions to the copper output of the State.

There is no accurate record of the output of this district in the early days, but from the records of the production of the State it is estimated that to the close of 1912 it has yielded approximately 115,500,000 pounds of copper. The production for 1912 was approximately 6,000,000 pounds. In total output the district ranks twelfth and in production for 1912 seventeenth among the copper districts of the country.

The ores,[1] consisting of pyrite and chalcopyrite, occur as lenticular bodies replacing schist. The ores vary in different parts of the district from those carrying nearly pure pyrite and chalcopyrite with very low gold and silver content to ores carrying considerable lead, zinc, and precious metal. The ores treated in the district during 1912 averaged about 5.1 per cent in copper, with about 2.2 cents in precious metal per pound of copper.

The matte smelter of the Penn Mining Co. was operated in the district. There was also important production of copper from the Ludlow district, San Benito County.

COLORADO.

In 1912 Colorado produced 7,963,520 pounds of blister copper, as compared with 9,791,861 pounds in 1911. Although the State has no important producing district in which copper is the principal metal, yet it ranked tenth among the copper-producing States in 1912. The total recorded output for the State from the beginning of the industry has been 221,507,444 pounds, or 1.26 per cent of the total output for the United States since 1845. It is probable that the actual output is somewhat in excess of this figure, as some of the copper assigned in the earlier Survey reports to "lead desilverizers" should doubtless be credited to Colorado.

The main production has been derived from the treatment of mixed ores in which copper was of minor importance, including lead-silver ores and pyritic ores rich in gold and silver. The largest production in 1912, as in previous years, was from Lake County and from San Juan, Hinsdale, Ouray, San Miguel, Clear Creek, and Gilpin counties. Leadville and the San Juan-Ouray districts have been the greatest producers of copper. Much of the output is recovered as matte in lead furnaces.

[1] Knopf, Adolph, Bull. Dept. Geology Univ. California, vol. 4, p. 411. Read, J. A., Econ. Geology, vol. 2, 1907, p. 380. Lang, Herbert, Eng. and Min. Jour., vol. 84, 1907, p. 909.

IDAHO.

During 1912 Idaho produced 7,182,185 pounds of blister copper, as compared with 4,514,116 pounds in 1911. The State has made a small and irregular output of copper since 1884, but only since 1903 has it been a steady and important producer. To the close of 1912 it had a recorded output of 66,253,985 pounds.

The Coeur d'Alene district furnished most of the copper output for 1912 and has been the most productive copper district in the State. Complete figures for the copper output of the district are not on record, but the total production has been approximately 49,293,000 pounds.

The Snowstorm mine is the most important copper producer of the district. This deposit [1] consists of disseminated bornite, chalcocite, and chalcopyrite in certain beds of a pre-Cambrian quartzite; in the upper portion the deposit is oxidized. The lode varies from a few feet to 40 feet in width, and has been developed to a depth of 1,200 feet below the outcrop. Development is by tunnels. The ore, being highly siliceous, is well adapted for converter linings and consequently, previous to the introduction of basic linings, received favorable smelting rates. The shipping ore yields about 3 per cent copper, with about 6 ounces of silver and a little gold per ton.

The Alder Creek district in Custer County made a considerable production in 1912, the main producer being the Empire Copper Co.

The State contains other promising copper deposits, but owing to lack of development or poor transportation facilities they have not been active.

MICHIGAN.

The production of refined copper in Michigan in 1912 was 231,112,228 pounds, as compared with 218,185,235 pounds in 1911. The production of the mines during the year was 218,138,408 pounds of copper. The excess of the smelter production over that of the mines was due to the smelting of "mineral" produced prior to 1912.

The mining of copper in Michigan antedates the earliest visits of European explorers to the region. The production on a commercial basis, however, dates from 1845, since which time the district has been a steady producer and an important factor in the copper industry of the world. To the close of 1912 Michigan has produced 5,205,717,606 pounds of copper, or 29.53 per cent of the output from the United States since 1845. For many years subsequent to 1845 Michigan was the most important copper-producing State, and in total output it is second only to Montana. The entire output is from the Keweenaw or Lake Superior district.

In the value of metal output, in the profits resulting from this output, in the development of mining and metallurgical processes, and in the general high standing of the companies conducting the operations, the district takes high rank among the great mining camps of the world. Previous to the perfection of the electrolytic process of refining, "Lake" copper enjoyed the distinction of being the highest grade produced, and even to the present time it sells at a figure slightly higher than the copper from other districts.

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[1] Ransome, F. L., and Calkins, F. C., The Geology and ore deposits of the Coeur d'Alene district, Idaho: Prof. Paper U. S. Geol. Survey No. 62, 1908, pp. 150–152. Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. U. S. Geol. Survey No. 540–E, 1913.

Although the district has been an active producer for 65 years, most of the older mines still have large reserves of ore and new mines are being opened, while much territory remains to be prospected. Moreover, it is claimed that a large tonnage of the mill tailings produced when milling methods were less efficient than at present can be retreated at a profit.

The more important new developments during the last few years have been made in the southern part of the district, and active development was continued in this section during 1912. The lodes in this section are apparently more "bunchy" than those farther north, but prospects of developing payable deposits in addition to those already producing are promising.

Of the new developments during the year, the rich drill cores secured from the Mayflower lode and the developments of the White Pine Copper Co. are worthy of mention. The encouraging results at both these localities have resulted in activity on neighboring properties.

The Lake Superior region is unique in being the only district from which a large output is derived from native copper. The rocks [1] of the district comprise a thick series of rather basic lava flows and intercalated beds of conglomerate and sandstone of pre-Cambrian age. These have been tilted so that they have a northwest dip, usually rather steep, and strike in a general northeast-southwest direction. The copper occurs in the cellular portion of the lava flows, which form the amygdaloid lodes, and as a cement and to some extent a replacement of the conglomerate pebbles forming the conglomerate lodes. Copper also occurs in fissures crossing the formations, but at present these are of little commercial importance, though in the early days of the district considerable copper was derived from this type of deposit. A little native silver occurs with the copper. The lodes are of low grade, but characterized by great extent and rather uniform distribution of the metallic content. This, together with the fact that the ore is susceptible of high concentration with low cost of refining the resultant "mineral," makes it possible to work these low-grade deposits at a good profit. The native copper occurs in the lodes in masses varying from microscopic size to bodies weighing hundreds of tons. The richest lode mined at present yields less than 1.5 per cent copper, and the poorest rock treated yields but little above five-tenths of 1 per cent of metal. For this low-grade ore to be profitable it must be handled on a large scale; this has resulted in the construction of the immense plants that characterize the Lake district. The lodes are worked for the most part through inclined shafts, though some of the deeper deposits are opened by vertical shafts. The workings have been extended in some cases to a mile in vertical depth, or about a mile and a half down the lode. Pillars of rock are left to keep the lodes open, and dry walls constructed from the waste sorted underground serve the same purpose in some of the mines. Much timber, however, is required in some of the mines, especially those operating on the conglomerate lodes.

[1] For detailed description of the geology and mining see Irving, R. D., Mon. U. S. Geol. Survey, vol. 5; Geol. Survey Michigan, vols. 5 and 6. Rickard, Eng. and Min. Jour., vol. 88. Pumpelly, Raphael, Geol. Survey Michigan, vol. 1, 1873. Lane, A. C., and Hubbard, L. L., Geol. Survey Michigan, vol. 4, 1898. Rominger, C., Geol. Survey Michigan, vol. 5, 1905. Rice, C. T., Copper mining at Lake Superior: Eng. and Min. Jour., vol. 94, pp. 119, 171, 217, 307, 365. Hore, R. S., Mineral resources of Michigan; Mich. Geol. and Biol. Survey, 1911, pp. 15–115. Van Hise, C. R., and Leith, C. K., The geology of the Lake Superior region: Mon. U. S. Geol. Survey, vol. 52, 1911, pp. 573–591.

The rock coming from the mines is crushed by steam stamps and concentrated, producing "mineral" containing an average of about 65 per cent copper. In recent years several regrinding plants have been constructed for the finer grinding and concentration of material that had previously been discarded as tailings. The "mineral" is subjected to a combined smelting and refining process. A small amount of "mass" and "barrel work" copper are sorted out at the mine and go direct to the smelter. A portion of the output is refined electrolytically; this consists of copper sufficiently argentiferous to make the recovery of silver profitable, and of copper containing so high a percentage of impurities that further refining is necessary for certain uses. During 1911 slightly over 20 per cent of the output was refined electrolytically.

Silver in important amount is recovered only from the copper treated electrolytically. The average recovery per ton of rock from which the copper was refined electrolytically was approximately 0.211 fine ounce.

In the following table is given the production of individual companies compiled from their annual reports, together with the cost of production and the price received for the copper. The average cost of production for the district was approximately 10.28 cents per pound, and the average price received was 16.44 cents per pound, or an average profit of 6.16 cents per pound.

Production of copper by Michigan mines for 1911 and 1912, in pounds, compiled from the annual reports of the producing companies.[a]

Company.	1911	1912	Cost per pound, 1912.	Price received per pound, 1912.	Profit, 1912.
	Pounds.	*Pounds.*	*Cents.*	*Cents.*	*Cents per pound.*
Ahmeek	15,196,127	16,455,769	7.85	16.56	8.71
Allouez	4,780,494	5,525,455	13.52	16.318	2.798
Baltic	15,370,449	13,373,961	10.94	16.16	5.22
Calumet & Hecla	74,130,977	67,856,429	9.86	16.65	6.79
Centennial	1,493,834	1,742,338	13.46	16.36	2.90
Champion	15,639,426	17,225,508	8.88	16.16	7.28
Franklin	820,203	1,710,651	.....	16.794	.....
Gratiot	14,275	.....	.....	.....	.....
Isle Royale	7,490,120	8,186,957	11.89	16.58	4.69
La Salle	280,598	.....	.....	.....	.....
Mass	1,326,898	2,045,006	.....	17.0205	.....
Mohawk	12,091,056	11,995,598	10.61	16.08	5.47
Osceola	18,388,193	18,413,387	10.36	16.52	6.16
Quincy	22,252,943	20,634,800	.....	16.24	.....
Superior	3,236,233	3,921,974	12.75	16.49	3.74
Tamarack	7,494,077	7,908,745	13.15	16.44	3.29
Trimountain	6,120,417	6,980,713	11.73	16.16	4.43
Victoria	1,303,331	1,224,911	.....	.....	.....
Winona	1,275,675	2,307,237	.....	16.306	.....
Wolverine	9,408,960	8,350,312	8.66	15.89	7.23
Average[b]	.....	.....	10.28	16.443	6.163

[a] Since this table includes mines reporting their output both for the calendar and for the fiscal years, and since some of the companies report the refined copper equivalent of mineral produced and others report refined copper, the amounts do not necessarily agree with the total of either mine or smelter output.

[b] Average includes only mines whose reports are for the calendar year.

The average copper yield per ton of rock milled during 1912 was 19.1 pounds, as compared with 20 for 1911. The average copper recovery from conglomerate rock for 1912 was 27.7 pounds per ton

and for amygdaloid 17.1 pounds per ton. The copper derived from the two types, respectively, was 27.3 and 72.7 per cent.

During 1912 the rock milled amounted to 11,411,941 tons, as compared with 10,978,827 tons for 1911.

The change in grade of ore handled by the Lake companies is shown in the following table. The figures are compiled from the annual reports of the companies.

Tonnage and yield of ore milled by Michigan copper companies in 1911 and 1912, compiled from the annual reports of the producing companies.

Company.	1911		1912	
	Tonnage.	Yield per ton.	Tonnage.	Yield per ton.
		Pounds.		*Pounds.*
Ahmeek	598,549	25.4	652,260	25.2
Allouez	288,610	16.56	333,618	16.56
Baltic	696,795	22.06	652,433	20.50
Calumet & Hecla	2,909,972	25.47	2,806,610	24.18
Centennial	86,543	17.26	106,517	16.36
Champion	734,392	21.30	765,306	22.51
Franklin			176,462	9.80
Gratiot	1,347	10.60		
Isle Royale	457,440	16.4	531,105	15.4
La Salle	18,970	14.77		
Mass	73,475	17.58	132,891	15.39
Mohawk	802,548	15.07	787,941	15.22
Osceola	1,246,596	14.8	1,246,557	14.8
Quincy	1,382,524	16.10	1,309,253	15.76
Superior	162,599	19.90	172,322	22.76
Tamarack	392,338	19.1	421,385	18.8
Trimountain	347,885	17.59	366,663	19.04
Victoria	126,894	10.53	131,955	9.28
Winona	97,445	13.0912	181,148	12.7367
Wolverine	401,308	23.45	388,502	21.49

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, the Lake transportation being brought into the heart of the district by Portage Lake and the Houghton ship canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central railroads and is connected with the main lines of traffic by the Chicago, Milwaukee & St. Paul and the South Shore & Atlantic railroads.

MONTANA.

The output of blister copper from Montana in 1912 was 308,770,826 pounds, as compared with 271,814,491 pounds in 1911. The State thus ranks second to Arizona in copper production.

The first record of production of copper from Montana is for 1868, but the State did not become an important contributor of this metal until 1880. Since that time there has been a steady and rapid increase in the copper output. To the close of 1912 the State has yielded 5,907,024,710 pounds, or 33.51 per cent of the total output of the United States since 1845. In total production the State ranks first and in the output for 1912 it ranked second. The Butte district has furnished nearly the entire output.

Three copper-smelting plants were operated in Montana in 1912: The Smelter of the East Butte Mining Co., at Butte, and the smelters of the Anaconda Copper Co., at Anaconda and at Great Falls.

Butte district.—In 1912 the Butte district, Silver Bow County, produced about 308,000,000 pounds of copper, or about 24.8 per cent of the total output of the country.

The presence of copper minerals in the district had been known since the discovery of gold in 1864, and attempts were made to treat the ores as early as 1866; but it was not until the late seventies that Butte began to attract attention as a copper camp, and large production did not begin until a railroad reached the district in 1881. To the close of 1912 Butte has produced about 5,894,200,000 pounds of copper, or 33.4 per cent of the total output of the country since 1845. In total production and in the output for 1912 it ranks first among the copper-producing districts of the United States.

The copper ores [1] of the district occur as replacement veins in a granitic rock known technically as quartz monzonite. These veins form complex systems of slightly different ages.

The principal original ore minerals in the copper veins are pyrite, enargite, bornite, chalcocite,[2] chalcopyrite, with varying amounts of sphalerite. It had been generally considered that the commercial ore has resulted from the process of enrichment and that the material produced by the original mineralization was too low in copper content to be of commercial importance; but more recently many geologists have considered that all the ore minerals in the deeper levels are of primary origin—that is, that they were deposited from ascending solutions and that only the upper part of the deposit has been extensively effected by enrichment resulting from descending solutions. The ores may be divided into two general classes as regards treatment—the sulphide-quartz smelting ores and the concentrating ores consisting of altered quartz monzonite impregnated with grains and veinlets of sulphide. In the early days of mining in the district chalcocite was by far the most important copper mineral. With increase in depth of the workings, however, the copper derived from enargite and bornite has increased until it probably about equals the quantity derived from chalcocite.

The grade of ore mined in the district is regulated to a considerable degree by the possibility of profitable treatment. An increase in the price of copper or a decrease in the cost of mining and treatment permits the mining of lower-grade ores. In 1912 the average yield was 3.02 per cent copper, as compared with 3.17 per cent in 1911, 3.13 per cent in 1910, and with 3.08 per cent in 1909. In 1912 smelting ores averaging 5.54 per cent copper furnished about 28 per cent of the output derived from ores, and concentrating ores averaging 2.51 per cent furnished about 72 per cent. The ores averaged 2.09 ounces silver and 0.0065 ounce gold per ton, the precious metal content reducing the cost of copper about 2.35 cents per pound.

The mines and reduction works of the Anaconda Copper Mining Co. were operated without serious interruption throughout the year and the output of copper was larger than for several years previous.

[1] Weed, W. H., Geology and ore deposits of the Butte district, Montana: Prof. Paper U. S. Geol. Survey No. 74, 1912. Kirk, C. T., Conditions of mineralization in the copper veins of Butte, Mont.: Econ. Geology, vol. 7, p. 35.

Special attention is called to the important series of articles on the Butte district published in the Bulletin of the American Institute of Mining Engineers, August, 1913, treating of the geology, mining methods, and metallurgical methods of the camp.

[2] Sales, R. H., Econ. Geology, vol. 5, 1910, p. 681. Graton, L. C., and Murdoch, Joseph, The sulphide ores of copper: Bull. Am. Inst. Min. Eng. No. 77, May, 1913, p. 767.

According to the annual report of the president a total of 34.1 miles of development work resulted in the addition to the ore reserves of a large tonnage of ore in excess of the amount extracted. The developments were especially satisfactory in the ground tributary to the Leonard, Tramway, Badger State, West Gray Rock, Original, Stewart, and Gagnon shafts.

The work of installation for compressed air hoisting was continued through the year. The installation of electric pumps at the High Ore shaft was completed and the installation of electric haulage was continued. It is estimated that the use of electric power is materially reducing the cost of operation.

The mines of the company produced during the year 4,576,289.24 tons of ore and 3,667.51 tons of precipitates, or a total of 4,579,956.75 tons.

The reduction works treated for all companies during the year 3,880,203.37 dry tons of ore and other cupriferous material at Anaconda and 1,189,039.10 dry tons of ore and other cupriferous material at Great Falls. Of this quantity, 4,486,870.98 tons of ore furnished from the company's mines, 581,031.97 tons of purchased ore, together with 1,337.52 tons of precipitates from the Old Works, were treated, from which there was produced 222,763,670 pounds of fine copper, 9,702,604.52 ounces of silver, and 52,563.891 ounces of gold at Anaconda, and 71,710,491 pounds of fine copper, 1,312,132.45 ounces of silver, and 8,750.576 ounces of gold at Great Falls, or a total production of 294,474,161 pounds of fine copper, 11,014,736.97 ounces of silver, and 61,314.467 ounces of gold.

At the North Butte mine development work resulted in the finding of the eastward extension of the Snowball vein and the discovery of an important body of ore in the Edith May vein on the 2,400-foot level. It is reported by the company that ore reserves at the close of the year were larger than at any time in the history of the company. The reserves are estimated to average 4.5 per cent copper and 4.5 ounces silver per ton. The company produced and treated 425,248 tons of ore and 49 tons of precipitates, yielding 26,480,123 pounds of copper, 1,377,468 ounces of silver, and 1,367 ounces of gold.

During the year electric haulage was installed on the lower levels of the mine.

At the mines of the East Butte Copper Mining Co. development was largely confined to known ore bodies but during this work some hitherto unknown bodies were discovered. The mines produced 99,458 tons of ore averaging 5.78 per cent copper. Of this amount 72,865 tons averaged 6.98 per cent copper and 26,593 tons averaged 2.48 per cent copper. There was treated at the reduction works a total of 181,774 tons of ore (including custom ore) producing 14,709,460 pounds of copper, 370,675 ounces of silver, and 16,920 ounces of gold. The average cost of production per pound was 9.698 cents.

The Tuolumne Copper Mining Co. produced 46,683 tons of ore containing 4,416,047 pounds of copper, 131,867 ounces of silver, and 259 ounces of gold.

The average copper content of first class ore mined during the year was 7.35 per cent, with 3.38 ounces of silver per ton. Second class ore averaged 4.05 per cent copper, with 2.58 ounces of silver per ton.

NEVADA.

The production of blister copper in Nevada in 1912 was 83,413,900 pounds, as compared with 65,561,015 pounds in 1911. The increase in production was largely due to the output from the Yerington district, which began important production early in the year.

The earliest record of the production of copper in Nevada was for 1873, but it did not become an important factor in the copper industry until 1908, when production from the Ely district began.

To the close of 1912 the State has a recorded production of 286,914,012 pounds, or 1.63 per cent of the output of the country since 1845. To this should probably be added a small but unknown quantity produced as bluestone in the early days of mining in the State and used locally in the treatment of gold and silver ores. In total production Nevada ranks seventh and in the output for 1912 fifth among the copper-producing States.

A large part of the output was from two districts, the Ely district in White Pine County and the Yerington district in Lyon County.

Ely district.—The Ely district, White Pine County, was the largest producing district in the State in 1912. Although it has long been known that the district contained copper deposits, active development on an important scale began but a few years ago and important production did not begin until 1908, when the Steptoe Valley smelter and concentrating plant was completed.

During 1912 the district produced about 67,400,000 pounds of blister copper, and to the close of 1911 the output has been about 257,300,000 pounds. The district has yielded 1.46 per cent of the total output of the country since 1845, and it produced 5.42 per cent of the output in 1912. In total production it ranks ninth and in the production for 1912 sixth among the copper districts of the country.

The production for 1912 was somewhat reduced owing to labor troubles in the district in the latter part of the year.

The district is in the Egan Range, the geology [1] of which may be summarized as follows: Paleozoic limestones and shales have been invaded by a granitic intrusive technically known as quartz monzonite porphyry, probably of Mesozoic age. Later the area was buried beneath lava flows which have been in large part removed by erosion.

The copper ores are of two types, replacement deposits in the limestone, and disseminated deposits in the altered monzonite porphyry. The deposits in the limestone are near the quartz monzonite and are associated with garnet and other contact silicates and usually with abundant jasperoid. The deposits of this type thus far developed have been largely oxidized and to the present time there has been a relatively small production from them.

The disseminated ores are principally included in the monzonite porphyry area though they extend into the adjacent sediments to some extent. The monzonite porphyry has been much shattered and altered, the hornblende and feldspars of the monzonite being altered to orthoclase, quartz, sericite, and brown mica. The metallic minerals of the primary ore, pyrite and chalcopyrite, occur as veinlets and disseminated grains in the altered rock. The commercial ore has resulted from the process of enrichment. In this enrichment the copper in the upper part of the deposit has been in part taken into solution and

[1] Lawson, A. C., Bull. Dept. Geology Univ. California, No. 4, p. 284. Spencer, A. C., Bull. U. S. Geol. Survey No. 529, 1913, p. 189.

redeposited on the sulphides lower in the deposit, usually as chalcocite. The commercial ore consists of grains of pyrite and chalcopyrite partly or entirely replaced by chalcocite. The leached capping is of varying thickness, but for a part of the deposit it is thin enough to permit of its removal and the mining of the ores by steam shovel; for the remainder underground methods of mining are necessary.

For the Eureka section of the Nevada Consolidated Copper Co.'s area the average thickness of the capping is 87.1 feet, and of the profitable ore 190 feet; for the Hecla area the capping is of an average thickness of 101.4 feet and the ore is 280.3 feet thick; and for the Liberty area the capping is 154.7 feet thick and the ore 193.3 feet thick.

During the year 2,985,217 tons of copper ore mined in the district produced concentrates containing 64,932,446 pounds of copper. The average recovery in concentrates per ton of ore from the district was 1.09 per cent of copper, with about 17 cents in gold and silver per ton of ore. Smelting ores amounting to 37,865 tons contained 3.22 per cent of copper, with 40 cents in gold and silver per ton.

A total of 50,010,087 tons of ore have been developed by the Nevada Consolidated Copper Co., with an average copper content of 1.70 per cent. Of this total 1,419,300 tons, with an average content of 1.21 per cent, are regarded as unprofitable on account of slopes, leaving a total of profitable ore developed of 48,590,787 tons, averaging 1.71 per cent copper. To December 31, 1912, a total of 9,737,236 tons of ore, averaging 1.90 per cent copper, had been milled and smelted, leaving 38,853,551 tons, averaging 1.67 per cent copper, of profitable ore remaining in reserve December 31, 1912.

During the year the following tonnage of sulphide ore was mined and shipped to the concentrator:

Copper ore mined and shipped by Nevada Consolidated Copper Co. in 1912.

	Short tons.	Per cent copper.
Eureka pit	2,054,758	1.603
Liberty pit	170,748	
Hecla pit	371,485	
Veteran mine	253,365	2.605
Total	2,850,356	1.690

Siliceous carbonate ores amounting to 88,428 dry tons and averaging 2.78 per cent copper were mined, of which 35,216 tons were crushed and delivered to the smelter, and 53,212 tons were put into storage at the mine.

The following table shows the result of operations at the concentrator:

Operations of Nevada Consolidated Copper Co. for the year ending Dec. 31, 1912.

Ore treated (dry)	short tons	2,853,515
Average copper assay	per cent	1.672
Percentage of extraction (copper)	do	68.25
Ratio of concentration		9.09
Average value in gold	ounces	.016
Average value in silver	do	.049
Percentage of extraction (gold)	per cent	45.84
Percentage of extraction (silver)	do	50.11
Average gold and silver recovered per ton of ore	cents	16.48
Average copper in concentrates		10.49

There were improvements made in the smelting plant during the year, greatly increasing the efficiency of the reverberatories. The reverberatories are now all fired by oil.

The yield from all ores mined and treated and from siliceous carbonate ores delivered to the smelter, has amounted to 63,063,261 pounds of copper for the year 1912. The total cost per pound of copper has been 8.86 cents.

Operations of the Giroux Consolidated Mines Co. were largely confined to preparation for and extraction of ore for shipment to the Steptoe Valley concentrator. Shipments were started on May 1 and were continued during the year except as interrupted by the labor strike in October.

A total of 140,877 tons of ore with an average copper content of 2.15 per cent was shipped to the concentrator. In addition to the concentrating ore, 410 tons of smelting ore were shipped to smelters. The total metal production from ores was 3,817,083 pounds of copper, 1,232.027 ounces gold, and 3,031.64 ounces silver.

There was small production by other companies.

Yerington district.—In the Yerington district production began early in 1912 and a total output of 14,700,000 pounds of blister copper was made during the year.

Copper ores have been mined in the district for many years. In the early days considerable natural bluestone was mined and used in the treatment of gold ores at Virginia City. Later an attempt was made to smelt the ores, but with little success. No accurate data of the total output of the district has been compiled, though it has not been large. During the last few years development of ore by several companies has been in progress and it is reported that considerable ore carrying copper values of 3 per cent or better have been opened.

The ores of the district according to Ransome [1] are of three types of occurrence:

1. Irregular bodies formed by metasomatic replacement of limestone and genetically associated with metamorphism of a kind usually attributed to contact action of intrusive rocks; (2) metasomatic vein deposits in altered limestone; and (3) metasomatic vein deposits in granodiorite.

The most important developments are of ore bodies of the first type. The original sulphides of these are pyrite and chalcopyrite in various proportions, with a gangue of pyroxene, amphibole, epidote, garnet, and calcite.

The smelter of the Mason Valley Mines Co. was blown in on January 6, 1912, and operated for the rest of the year, treating 98,912 tons of Mason Valley ore, 142,910 tons of custom ore, and 15,768 tons of limestone. There were produced 19,849 tons of matte containing 16,058,493 pounds of copper, 916.59 ounces gold, and 49,318.18 ounces silver.

The Nevada-Douglas Copper Co. produced 106,483 tons of ore which yielded 9,020,640 pounds of copper, or an average of 84.71 pounds of copper, per dry ton of ore. During the same period lessees shipped 551 wet tons.

Considerable copper ore was produced from other districts, notably the Goldfield, Pioche, and Santa Fe districts.

[1] Ransome, F. L., The Yerington district, Nevada: Bull. U. S. Geol. Survey No. 380, 1909, p. 99.

NEW MEXICO.

The production of blister copper from New Mexico in 1912 was 29,170,400 pounds, as compared with 2,860,400 pounds in 1911. The large increase was due to the beginning of important production by the Chino Copper Co. of the Santa Rita district.

Production of copper from New Mexico began in the last years of the eighteenth century, native copper from the mines of Grant County being carried to Mexico City and coined into money. A little copper is reported for about the year 1860, but New Mexico did not have a steady output until after 1880 and did not become an important factor in production until 1900. From 1845 to 1912 New Mexico has a recorded output of 124,353,963 pounds of copper, or 0.71 per cent of the output of the country since 1845. The principal production has been from the districts in Grant County.

Santa Rita district.—The Santa Rita district, in Grant County, made a large increase in production in 1912 due to the completion of the mill and the beginning of production on a large scale by the Chino Copper Co. This was probably the first district in the West from which important copper production was made, the output beginning in the closing years of the eighteenth century, the metal going to Mexico for coinage. There are no accurate records of the production for this early period of operation, but from the best sources available it is estimated that the total production to the close of 1912 has been approximately 129,400,000 pounds.

The geology [1] of the district is rather complex. The sedimentary series, consisting of quartzite, shales, and limestone, has been invaded in post-Cretaceous time by granitic and porphyritic rocks of monzonitic and dioritic composition. After a period of erosion the area was buried beneath Tertiary volcanic flows, which in turn have been largely removed by erosion.

The copper deposits may be divided into two types, contact deposits and disseminated deposits. The contact deposits occur as replacement of limestone near the porphyry contact and have been most extensively worked in the Hanover end of the district.

In the disseminated deposits the ore minerals occur as small veins and grains of mineral in shattered quartzite and highly altered intrusives. Unlike many of the disseminated deposits, much of the copper occurs native and as the oxide, though chalcocite ores are also abundant. Prior to 1912 the main production came from shallow workings following high-grade streaks of native copper, and from oxide and chalcocite ores.

Since 1909 the Chino Copper Co. has been actively developing the main mineralized area by means of churn drills, and production by this company began late in 1911. The management gave the developed ore at the close of 1912 as over 90,000,000 tons, of an average grade of about 1.8 per cent copper.

It is stated that nearly 90 per cent of the developed ore can be extracted by steam-shovel methods, and a part of the area has already been stripped and is being mined by this method.

[1] Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, p. 305. Paige, Sidney, The geologic and structural relations at Santa Rita (Chino), N. Mex.: Econ. Geology, vol. 7, p. 547. A report on the geology of the Silver City quadrangle is in preparation by the United States Geological Survey.

The first section of the mill at Hurley was placed in operation in October, 1911, and at the close of 1912 the five sections of the mill had been completed. The mill was designed for a capacity of 5,000 tons per day but has proven capable of treating 6,000 tons per day when in full operation

During the year 1,120,375 tons of ore were treated at the mill. The average copper content of the ore was 2.077 per cent and the average recovery of copper contained in concentrates was 61.63 per cent.

The recovery varied greatly in different types of ore. The recovery from the more highly oxidized ores near the surface was only a little over 54 per cent, while from the more favorable types of ore recoveries of nearly 75 per cent were made.

The total production for the year of copper in concentrates was 28,684,208 pounds, the average grade of concentrates being 21.2 per cent copper and the ratio of concentrates 16.56 tons into 1.

In addition to copper in concentrates there was produced from crude ore 553,758 pounds of copper, making a total production for the year of 29,237,966 pounds, which after deducting smelting loss is equivalent to 27,776,088 pounds.

The average cost of copper produced from concentrates, after deducting for smelter allowances, was 7.69 cents per pound, the cost for crude ore shipments was 6.98 cents per pound.

The ore and concentrates are shipped to the El Paso smelter for treatment.

The district is served by a branch line of the Santa Fe Railway connecting with the main line and with the Southern Pacific at Deming.

Burro Mountain district.—The Burro Mountain district, southwest of Silver City, made but a small production in 1912. The total production from the district has probably been about 10,000,000 pounds of copper.

The Burro Mountain [1] consists of a pre-Cambrian complex that has been intruded by monzonite porphyry. The copper ores occur mainly as impregnations and replacements along irregular fractures and zones of crushing. The primary sulphide is cupriferous pyrite, but the workable deposits have resulted from the enrichment of the primary ores.

During 1912 the Burro Mountain Copper Co. controlled by Phelps, Dodge & Co. purchased the mines of the Chemung Copper Co. It is stated in the report of the company that sufficient ore is blocked out to justify the erection of a concentrator and that two 500-ton sections are being planned.

The Lordsburg district, with an output of about 3,000,000 pounds, was the only other important producer in the State.

TENNESSEE.

The production of blister copper from Tennessee in 1912 was 18,395,256 pounds, as compared with 18,965,143 pounds in 1911.

The entire output was from the Ducktown district located in the extreme southeastern part of the State in Polk County. The district

[1] Lindgren, W., Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, p. 321. Paige, Sidney, Metalliferous ore deposits near the Burro Mountains, Grant County, N. Mex.: Bull. U. S. Geol. Survey No. 470, 1911, p. 131.

was one of the earliest large producers in the country. Operations began about 1850, and from that date till the close of the Civil War there was a large production from the "black-copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper & Iron Co. began operations. Since that time the district has been a steady producer from the primary sulphide ores. To the close of 1912 the total output of the district has been approximately 249,055,000 pounds.

The ores [1] occur as steeply dipping lenses replacing calcareous bands in schist, the ore bodies in general conforming to the dip and strike of the schistosity of the inclosing rock. The principal sulphide is pyrrhotite, with subordinate pyrite, chalcopyrite, and sphalerite. Extensive gossans capped the ore bodies, and it was the enriched zones underlying these that furnished the rich chalcocite ores that were extracted during the first period of activity.

In 1912 the ores of the district yielded 30.6 pounds of blister copper per ton, or 1.53 per cent, with an average value of 7 cents in gold and silver per ton of ore. A part of the copper is marketed without electrolytic refining. The fact that the ores can be extracted with little timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor, have made it possible to mine and treat these low-grade ores at a profit.

The pyritic process of smelting is practiced successfully by both companies. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

Sulphuric-acid plants were operated by both the Ducktown Sulphur, Copper & Iron Co. and the Tennessee Copper Co. The successful operation of these plants has apparently not only solved the troublesome smelter-smoke problem, but added very materially to the revenue of the companies. The sulphuric-acid production will probably be fully as important in the future as the copper output.

The Tennessee Copper Co. treated 444,289 tons of ore from the district, which yielded 13,252,634 pounds of copper, or an average of 29.8 pounds per ton of ore. The average cost of the production of copper was 9.654 cents per pound.

The production of sulphuric acid for the year by the Tennessee Copper Co. was 192,084 tons 60° Baumé, which at the average price for this product was worth approximately $1,177,000.

The company estimates the ore reserves at the close of the year as follows: Available ore, 3,691,000 tons; probable ore, 1,380,000 tons, or a total ore reserve of 5,071,000 tons. The district is served by a branch line of the Louisville & Nashville Railroad, the mines and smelters of the companies being connected with this by private lines.

[1] The deposits have been described by Heinrich, Carl, Trans. Am. Inst. Min. Eng., vol. 25, p. 173. Weed, W. H., idem, vol. 30, p. 452. Kemp, J. F., idem, vol. 31, p. 224. Higgins, E., Eng. and Min. Jour., vol. 86, 1908, pp. 1237-1241. Channing, J. P., Min. and Sci. Press, vol. 96, 1908, p. 97. Gottsberger, B. B., Mining World, vol. 29, 1908, pp. 911-914. Weed, W. H., Ore deposits of the Appalachian States: Bull. U. S. Geol. Survey No. 455, 1911, p. 152. Emmons, W. H., and Laney, F. B., Preliminary report on the mineral deposits of Ducktown, Tenn.: Bull. U. S. Geol. Survey No. 470, 1911, p. 151. Laney, F. B., The manufacture of sulphuric acid from smelter fumes at Ducktown, Tenn.: Mineral Resources U. S. for 1911, pt. 2, U. S. Geol. Survey, 1912.

UTAH.

In 1912 Utah produced 132,150,052 pounds of blister copper, as compared with 142,340,215 pounds in 1911. The decrease was due to labor troubles in the Bingham camp which resulted in the closing of the mines for some time during the latter part of the year.

The first record of production of copper from Utah is for 1872. The State did not become an important copper producer, however, until late in the nineties, since which time the growth of the industry has been steady and rapid. The total recorded output from the State to the close of 1912 has been 929,194,840 pounds, 5.27 per cent of the output from the United States since 1845. In 1912 Utah produced 10.62 per cent of the output. In total output and in the production for 1912 it ranks fourth among the copper-producing States.

Two copper-smelting plants were operated in the State during 1911, the Garfield smelter at Garfield, and the International smelter at Tooele.

Bingham district.—The Bingham or West Mountain district, Salt Lake County, made about 112,000,000 pounds of blister copper in 1912, as compared with about 125,500,000 pounds in 1911.

As already noted, labor troubles resulted in a greatly reduced output for the last quarter of the year which is responsible for the decrease in output. The presence of copper minerals has been known since the early days of mining in the district, but for many years operations were confined to the production of lead, silver, and gold. Not until 1896 did the mining of copper ore become of commercial importance. To the close of 1912 the district has produced approximately 702,500,000 pounds, or 3.98 per cent of the output of the country since 1845. For 1912 the district yielded 9.01 per cent of the total production. In total output the district ranks sixth among those of the country and in the production for 1912 it ranks fourth.

The ore deposits of the district [1] are closely associated with masses of monzonite porphyry intruded into a series of quartzites with intercalated beds of limestone and shale of Carboniferous age. The copper ores are of two types of occurrence—as irregular replacement deposits of limestone, and as disseminated deposits through altered porphyry and quartzite.

In the early years of production most of the copper from the district was derived from the replacement deposits in limestone. These are massive bodies of pyrite carrying chalcopyrite in varying amounts and in places grading into ores carrying galena and sphalerite in important amounts. They occur as replacements of the limestone associated with fissures and usually not far from bodies of monzonite porphyry. Enrichment has not extended to great depth in this type of deposit and the enriched ores have been largely extracted. The ores vary greatly in copper content and consequently the average percentage derived for a given year depends largely on the grade that can be worked at a profit at the price of copper. In 1912 the ores yielded about 1.7 per cent copper and about $3 per ton of ore in gold and silver. About 420,000 tons of this type of ore was produced during the year, yielding about 13,900,000 pounds of copper.

[1] For detailed information see Boutwell, J. M., Economic geology of the Bingham mining district, Utah: Prof. Paper. U. S. Geol. Survey No. 38, 1905.

The primary mineralization of the disseminated type of ore consists of grains and veinlets of pyrite and chalcopyrite disseminated through shattered and altered monzonite porphyry and quartzite. The varying intensity of alteration of the monzonite porphyry has yielded different gangue minerals in different parts of the disseminated ore body, forming what is designated as "dark porphyry" and "light porphyry."

In the "dark porphyry," the hornblende and augite of the monzonite have been altered to brown mica, while the plagioclase feldspar has been altered in part to sericite and in part to secondary orthoclase. The abundant brown mica gives the rock a dark color. In the "light porphyry" the lime and magnesia have been largely removed and there has been a marked addition of potassium resulting in a rock composed essentially of quartz, secondary orthoclase, and sericite together with the metallic sulphides.

The commercial ore is the result of enrichment, the copper content of the upper portion of the deposit having been in part taken into solution and redeposited on the sulphides at greater depth. These secondary sulphides include both covellite and chalcocite. As contrasted with many similar deposits covellite is relatively abundant as a secondary sulphide. Secondary sulphides are relatively less abundant in the Bingham disseminated ores than in several similar deposits. The commercial ore body is an irregular layer covered by the leached and partly leached "capping" and underlain by the lean primary ore. The average thickness of the commercial ore as shown by the developments of the Utah Copper Co. to the close of 1912, was 424.3 feet. The thickness of the "capping" varies greatly at different points. As determined at the close of 1912 the average thickness on the Utah group is 84 feet, on the Boston group 134 feet, and on the Pay Roll group 206 feet, making an average thickness over the entire ore body of 110 feet. The disseminated ores are extracted by both steam shovel and underground methods. During the year about 5,935,000 tons of disseminated ore was mined in the district, yielding about 0.85 per cent of copper, and about 16 cents per ton in gold and silver.

The ores were treated at the mills at Garfield and at the Ohio Copper Co.'s mill at Lark. The ores and concentrates from the district were reduced at the Garfield smelter and the International smelter. The mills of the Utah Copper Co. treated 5,315,321 tons of ore, with an average copper content of 1.364 per cent. The average recovery was 66.32 per cent, equivalent to 18.09 pounds of copper per ton of ore treated. The total production in concentrates for the year by the Utah Copper Co. was 96,175,090 pounds, or after making deduction for loss in smelting, a net production equivalent to 91,336,337 pounds of refined copper. The average cost of producing this copper was 9.024 cents per pound. The net value of gold and silver amounted to 0.956 cents per pound of copper.

At the close of 1912 development had been carried on over an area of 217.26 acres and ore estimated at 337,700,842 tons with an average copper content of 1.50 per cent had been developed and partly developed. Of this ore 21,200,842 tons with an average copper content of 1.542 per cent had been extracted prior to January 1, 1913, leaving ore reserves at that date of 316,500,000 tons averaging 1.495 per cent copper.

The Utah Copper Co.'s Magma mill at Garfield has a rated capacity of 12,000 tons per day, and the Arthur mill, the remodeling of which was nearly completed during the year after the design of the Magma mill, has a rated capacity of 8,000 tons. It is estimated that the mills when running at capacity can treat 21,000 tons of ore per day.

During the year arrangements were completed for the substitution at both the mines and mills of hydroelectric power furnished by the Utah Power & Light Co. for the steam power previously used. It is expected that by the close of 1913 the Power Co. will be able to furnish the power required for all operations.

Operations were carried on throughout the year at the mine and mills of the Ohio Copper Mining Co. During the last five months of 1912 the company mined and concentrated 234,239 tons of ore, averaging 1.05 per cent in copper. The concentrates shipped to the smelter contained 2,343,439 pounds of copper, 1,920 ounces of gold, and 379,875 ounces of silver.

The Utah Consolidated Mining Co. shipped 159,143 tons of copper ore, averaging 2.146 per cent copper and 0.077 ounce of gold and 0.828 ounce of silver per ton. At the close of the year there was reported as in sight in the mine 251,500 tons of copper ore, averaging 1.90 per cent copper and 0.04 ounce of gold and 0.58 ounce of silver per ton. The ores were shipped over the aerial tram to the International smelter.

Several other companies in the district were important producers of copper and copper-lead ores, notably the Old Jordan mine of the United States Mining Co.

The district is served by a branch of the Denver & Rio Grande Railroad and the Bingham & Garfield Railway, controlled by Utah Copper Co. interests, connecting the mines at Bingham with the mills at Garfield. Cable tramways are employed to considerable extent; the ores from the Utah Consolidated mines are delivered to the International smelter in this manner, and ores from other mines are delivered to the railroad over cable tramways.

Tintic district.—The Tintic district in Juab County made a production of about 13,000,000 pounds of blister copper in 1912 as compared with about 10,900,000 pounds in 1911. The production of copper from the Tintic district is largely incidental to the production of other metals. The amount of ore in which copper is the most important metal constituent is relatively small. There has been a small output of copper from the district for many years, but no accurate statistics of the early output are available. Tower and Smith have made an estimate of the production to 1897, and by adding to this the production since that time, compiled from the best sources available, it is estimated that to the close of 1912 the district has yielded approximately 103,900,000 pounds of copper.

The occurrence of the ores [1] may be briefly summarized as follows: The sedimentary series, consisting of limestone and quartzite, has been intruded by an extensive mass of monzonite. The ores occur as replacement deposits in the limestone near the monzonite contact, as replacement veins in the igneous rocks and as replacement veins in the sedimentary series.

[1] For detailed report, see Tower, G. W., and Smith, G. O., Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1899, pp. 601–767.

The most valuable deposits developed are of the last-named type. The fissures are usually nearly vertical, and the replacement bodies are extremely irregular in form and variable in size. The original minerals were pyrite, galena, sphalerite, and enargite, with rich silver and gold minerals in a gangue of quartz and barite.

There has been little development below the water level, which is usually below 1,600 feet in the deposits in limestone, and oxidation to this point has been rather complete. Recent developments below the water level in some of the mines have been encouraging.

The Centennial-Eureka mine was the most important producer of copper in 1912 as in previous years, though important production was made by the Gold Chain, Mammoth, Grand Central, Opohongo, and a lesser production by other mines.

Frisco district.—The Frisco district of Beaver County made a production of about 3,000,000 pounds of copper in 1912, as compared with about 3,600,000 pounds in 1911.

The first important production of copper from this district was from the Horn Silver mine in 1889, and since that time there has been a production of copper from lead-silver ores and from small copper mines. The importance of the district as a copper camp dates from the starting of the mill in 1905 to treat ores of the Cactus mine. To the close of 1912 the district has yielded approximately 35,600,000 pounds of copper.

During 1912, as in previous years, the Cactus mine was the largest producer of copper, but important production was also made by the Old Hickory mine of the Majestic Mines Co. and other mines in the Frisco area contributed in smaller amount to the copper output.

The ores[1] of the area are of several types. Those of the Cactus mine consist of pyrite and chalcopyrite, disseminated in a highly brecciated and altered area of quartz monzonite. Most of the ore is of low grade and requires concentration before shipping. The company's report states that from September 1, 1910, to June 30, 1912, a total of 426,002 tons of ore were milled yielding copper in concentrates amounting to 5,747,983 pounds, and 701.48 tons of crude ore were shipped, containing 173,881 pounds of copper. The smelter recovery from ore and concentrates was 5,527,810 pounds of copper, 2,449.96 ounces of gold, and 43,691.71 ounces of silver. The report states that the mine has little ore reserve developed. The ore actually developed is stated at 105,000 tons averaging 1.4 to 1.5 per cent copper and it is estimated that perhaps 100,000 tons averaging 1 per cent copper can be recovered from old stopes; in addition there are possibilities of other bodies of ore in undeveloped ground. The mine is equipped with a 1,000-ton mill. Concentrates are shipped to the International smelter for treatment.

The ores of the Old Hickory mine are replacement deposits in limestone at the contact of quartz monzonite. The ores have a high iron content, being composed largely of magnetite.

Other mines in the area made smaller outputs of copper from copper and mixed ores.

Other districts of the State that contributed in important degree to the copper output were the Lucien, Ophir, Rush Valley, Park City, Snake Creek, and Little Cottonwood districts.

[1] For detailed description of the ore deposits, see Butler, B. S., Geology and ore deposits of the San Francisco and adjacent districts, Utah: Prof. Paper U. S. Geol. Survey No. 80, 1913.

OTHER STATES.

Maryland.—In 1912 Maryland produced 53,043 pounds of blister copper, as compared with 23,555 pounds in 1911. The production was from the New London district, Frederick County.

Missouri.—Missouri produced 440,725 pounds of copper in 1912 as compared with 640,411 pounds in 1911. The output is mainly recovered as a by-product in the dressing of lead ores.

North Carolina.—North Carolina produced 63,766 pounds of copper in 1912, as compared with 13,699 pounds in 1911. The output was from the Cullowhee district, Jackson County.

Oregon.—Oregon produced 311,860 pounds of copper in 1912, as compared with 125,943 pounds in 1911. To the close of 1912 the State has a recorded output of 2,887,587 pounds. The largest production in recent years has been from the Waldo district in Grant County.

Pennsylvania.—Pennsylvania produced 248,378 pounds of blister copper in 1912, as compared with 661,621 pounds in 1911. The copper is recovered as a by-product in the treatment of pyritiferous magnetite at the Cornwall mines, Lebanon County.

Virginia.—Virginia produced 96,753 pounds of copper in 1912 from the mines in Prince William County.

Washington.—Washington produced 1,069,938 pounds of blister copper in 1912, as compared with 195,503 pounds in 1911. The State contains no important producing district, the total recorded output to the close of 1912 being but 3,243,222 pounds.

The Tacoma smelter was operated principally on ores from outside the State.

Wyoming.—Wyoming produced 25,080 pounds of blister copper in 1912, as compared with 130,127 pounds in 1911.

To the close of 1912 the State has a recorded output of 25,998,979 pounds.

The Encampment district, the most important producer, was not active in 1912. Exact statistics of the output of this district are not available, but it has probably been in excess of 20,000,000 pounds.

The most important deposits of the Encampment district[1] occur in a zone of brecciated quartzite underlying schist. The original ore was chalcopyrite with possibly some pyrite. Enrichment has produced important bodies of chalcocite in the upper workings, but these give place to chalcopyrite at depth.

REFINERY PRODUCTION.

The refinery output of the United States was made by 13 plants, 9 of which employ the electrolytic method and 5 employ the furnace process on Lake Superior copper, the Buffalo plant employing both the electrolytic and the furnace refining method. Six of the large electrolytic refineries are located on the Atlantic tidewater, 5 Lake refineries are on the Great Lakes—4 in Michigan and 1 in New York. Only 2 plants are located west of the Great Lakes—1 at Great Falls, Mont., and 1 at Tacoma, Wash. In addition to these refineries, there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper.

The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

[1] Spencer, A. C., Copper deposits of the Encampment district, Wyoming: Prof. Paper U. S. Geol. Survey No. 25, 1904.

CASTING AND PIG COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for the uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries such low values in precious metals that, together with the value added to the copper by electrolytic refining, these values will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals is exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the casting copper, shown in the table, is from the Morenci-Metcalf district, Arizona. The pig copper is from this district and the Ducktown, Tenn., district. Both districts produce a rather high grade of blister carrying low values in precious metals, and it is found profitable to market much of it without electrolytic refining. During 1912 the production of new casting copper amounted to 24,777,266 pounds, and pig copper amounted to 37,279,613 pounds.

LAKE COPPER.

By Lake copper as used in this report is meant the output of the Lake smelters. Considerable of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or sold as some brand of Lake copper. Of the 231,112,228 pounds of copper produced by the Lake smelters, about 45,570,000 pounds were refined electrolytically either to free it from impurities or to recover the silver content.

ELECTROLYTIC COPPER.

Under electrolytic copper, as shown in the accompanying table, is included all new copper that was refined electrolytically, except that from the Lake district. In 1912 the production of electrolytic copper from primary materials of domestic origin amounted to approximately 914,935,371 [1] pounds, and that of foreign origin to 360,000,000 pounds. Electrolytic copper to the amount of 23,932,166 pounds was produced from secondary sources, making a total electrolytic production of 1,298,867,537 pounds for the year.

SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, etc., and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A careful canvass of plants producing secondary copper has been made by J. P. Dunlop, of the United States Geological Survey. One hundred and ninety plants reported a production from secondary sources. Concerning the output of secondary copper Mr. Dunlop states:

> The total quantity of secondary copper recovered, on the assumption that the brass remelted had an average copper content of 70 per cent, was 275,014,000 pounds, of which 29,082,000 pounds was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by

[1] The separation of refined copper into that of foreign and domestic origin is only approximate.

smelters of the latter class includes 85,246,000 pounds of pig copper, 18,564,000 pounds of copper in alloys other than brass, and 142,132,000 pounds of copper in remelted brass. At least 75,000,000 pounds was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only about 214,000,000 pounds was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. According to the Bureau of Foreign and Domestic Commerce, the exports of scrap brass fit only for remanufacture, for the calendar year 1912, were 28,870 000 pounds, and the imports were 6,596,000 pounds. Although many railways sell or turn in their brass and copper scrap to dealers in part payment for new material, the reports received show that the railways utilized in their own shops and foundries over 25,800,000 pounds of brass, in addition to 3,114,000 pounds of copper, and 3,626,000 pounds of copper in alloys other than brass.

As contrasted with lead and zinc, the uses for which copper is principally employed are such that a large percentage of the metal can be eventually recovered and returned to the trade. The period elapsing between the time when copper enters the trade and is returned as scrap varies, of course, greatly with the uses for which it is employed, and no data are available that will give even an approximation of this period. However long this period may be, it is evident that there will be an increase in the production of copper from secondary sources proportionate to the great increase in the consumption of copper. The production from old scrap in 1912 was 27.5 per cent of the domestic consumption of new copper. This compares with about 22 per cent for 1911, between 17 and 18 per cent for 1910, and between 12 and 13 per cent for 1909.

TOTAL REFINED COPPER.

The total production of new refined copper in 1912 was 1,568,104,478 pounds, the largest output in the history of the industry, exceeding that of 1911 by 134,229,452 pounds.

The production of electrolytic, Lake, casting, and pig copper from primary sources and the production of secondary copper by the regular refining plants in 1911 and 1912 is shown in the following table:

Production of primary and secondary copper by the regular refining plants in 1911 and 1912, in pounds.

	1911		1912	
	Domestic.	Foreign.	Domestic.	Foreign.
Primary:				
Electrolytic	823,507,764	332,604,223	[a] 914,935,371	[a] 360,000,000
Lake	218,185,236	.....	231,112,228	.....
Casting	22,977,534	.....	24,777,266	.....
Pig	36,600,269	.....	32,852,030	4,427,583
Total primary	1,101,270,803	332,604,223	[b] 1,203,676,895	[b] 364,427,583
	1,433,875,026		1,568,104,478	
Secondary:				
Electrolytic	19,093,622		23,932,166	
Casting	8,803,105		5,150,137	
Total secondary	27,896,727		29,082,303	
Total output	1,461,771,753		1,597,186,781	

[a] The difference in the total primary electrolytic copper as shown here and as given out by the Copper Producers' Association appears to be due to the fact that through a misunderstanding some electrolytic copper derived from scrap was included in the association's figures showing primary electrolytic copper.

[b] The distribution of refined copper of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible. The distribution as shown in the table has been changed from that given in the advance statement. The total, however, is not changed.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of 245,932,000 pounds of copper as copper

and in brass and other alloys of copper, making a total production of 275,014,000 pounds from secondary sources. Of this total at least 75,000,000 pounds was produced by remelting clean scrap produced in the process of manufacture of copper and brass articles.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution of the United States to the world's supply of copper for 1912 is found to be 1,843,000,000 pounds.

During 1912 reports were made by the Copper Producers' Association of the monthly output of marketable copper by the regular refining plants in the United States. The following table shows the output by months and the total for the year:

Monthly output of marketable copper in 1912, as reported by the Copper Producers' Association.

	Pounds.		Pounds.
January	119,337,753	August	145,628,521
February	116,035,809	September	140,089,819
March	125,694,601	October	145,405,453
April	125,464,644	November	134,695,400
May	126,737,836	December	143,354,042
June	122,315,240		
July	137,161,129	Total	1,581,920,287

COPPER SULPHATE.

The production of hydrous copper sulphate or bluestone by the refineries of the United States in 1912 was 39,077,700 pounds, having a copper content of about 9,887,800 pounds, as compared with 35,604,950 pounds of bluestone, having a copper content of about 9,008,000 pounds, in 1911.

STOCKS.

Returns from all smelting and refining companies show that the following stocks of electrolytic, Lake, casting, and pig copper were on hand at the beginning and end of the year 1912:

Stocks of refined copper, in pounds.

January 1, 1912	88,372,195
January 1, 1913	105,497,683
Increase during 1912	17,125,488

In addition to the stocks of refined copper, there were reported as at the smelters, in transit to the refineries, and at the refineries, blister copper and material in process of refining to the amount of 274,072,084 pounds on January 1, 1913, as compared with 219,864,749 pounds on January 1, 1912.

During 1912 the Copper Producers' Association reported the stock of the marketable copper held at all points in the United States on the first of each month. The following table shows the stocks held on the first of each month:

Stocks of marketable copper of all kinds on hand at all points in the United States on the first day of each month for 1912 and on Jan. 1, 1913, as reported by the Copper Producers' Association.

	Pounds.		Pounds.
January	89,454,695	August	50,280,421
February	66,280,643	September	46,701,374
March	62,939,988	October	46,701,374
April	62,367,557	November	76,744,964
May	65,066,029	December	86,164,059
June	49,615,643		
July	44,335,004	Jan. 1, 1913	105,312,582

IMPORTS AND EXPORTS.

IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1912 was 410,240,295 pounds, according to the records of the Bureau of Foreign and Domestic Commerce. The imports in 1911 were 334,607,538 pounds. The following table shows the character and source of copper-bearing materials imported during 1911 and 1912:

Imports of copper into the United States in 1911 and 1912, by countries, in pounds.

Country.	Ore, matte, and regulus.		Pigs, bars, ingots, plates, old, etc.	
	1911	1912	1911	1912
United Kingdom			9,004,461	1,404,118
Germany	430,518	1,217,055		
Spain	5,354,142	5,487,584	28,042,257	31,670,095
Canada	12,919,644	28,930,073	22,442,335	36,138,255
Mexico	16,648,071	18,069,987	97,115,574	124,742,193
Chile	15,305,335	26,749,545	5,175,823	8,627,421
Cuba	10,787,759	10,288,680		
Peru			42,545,939	43,891,439
Japan			20,030,447	19,511,402
Australia and Tasmania			22,426,670	24,700,333
Other countries	7,181,309	14,128,779	19,197,254	14,684,336
Total	68,626,778	104,871,703	265,980,760	305,369,592
Grand total			334,607,538	410,240,295

In 1912 ore to the amount of 470,498 tons, with a copper content of 81,867,371 pounds, and 29,051 tons of matte and regulus, with a copper content of 23,004,332 pounds, were imported. The copper imported as matte amd blister included a considerable portion of the 34,000,000 pounds of ore and matte that was treated in foreign plants during the year.

According to the reports of the smelters and refineries, approximately 364,400,000 pounds of new copper was produced in this country from foreign material.

EXPORTS.

The exports of metallic copper from the United States in 1912, amounted to 775,000,658 pounds, according to the Bureau of Foreign and Domestic Commerce. In addition to the exports of metallic copper, the copper content of 66,171 long tons of ore, matte, and regulus was exported in 1912, as compared with the content of 57,915 long tons in 1911.

Exports of domestic copper from the United States in 1911 and 1912, by countries, in pounds.

Country.	Ingots, bars, plates, and old.	
	1911	1912
United Kingdom	108,061,603	95,422,292
Austria-Hungary	44,200,202	38,558,151
Belgium	5,125,004	7,674,273
France	135,038,893	131,362,694
Germany	190,428,008	252,156,012
Italy	38,216,773	47,251,432
Netherlands	230,693,649	152,618,177
Russia in Europe	15,601,688	4,961,473
Other Europe	9,254,363	8,960,973
Canada	8,931,582	30,302,856
Other countries	1,001,443	5,732,325
Total	786,553,208	[a] 775,000,658

[a] About 3,500,000 pounds of the copper exported was old copper fit only for remanufacture.

The report of the Copper Producers' Association, which is based on a slightly different period, shows a delivery of 746,396,452 pounds for export.

CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1912 was about 775,978,332 pounds. In 1911 it was about 681,753,279 pounds. The method employed in determining the quantity of copper retained for domestic consumption is shown in the following table, which does not include stocks of copper held by consumers:

Apparent domestic consumption of refined new copper in 1911 and 1912, in pounds.

	1911	1912
	Pounds.	*Pounds.*
Total refinery output of new copper	1,433,875,025	1,568,104,478
Stock at beginning of year	122,803,656	88,372,195
Total available supply	1,556,678,682	1,656,476,673
Refined copper exported	[a] 786,553,208	[a] 775,000,658
Stocks at end of year	88,372,195	105,497,683
Total withdrawn from supply	874,925,403	880,498,341
Apparent consumption	681,753,279	[b] 775,978,332

[a] Exports of pigs, ingots, bars, etc., reported by the Bureau of Foreign and Domestic Commerce.
[b] The apparent consumption as here calculated differs considerably from the domestic deliveries reported by the Copper Producers' Association. This difference is accounted for in part by the difference in export figures as reported by the Bureau of Foreign and Domestic Commerce and the Copper Producers' Association, owing to the fact that the two sets of export figures are based on a slightly different period and therefore may show considerable difference for any one year, and in part due to the difference in refined new copper as shown here and reported by the Copper Producers' Association, as noted elsewhere

If to the 775,978,332 pounds of new refined copper is added the 275,000,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of about 1,051,000,000 pounds of new and old copper was available for domestic consumption.

The following table shows the monthly deliveries of copper for domestic consumption and export as reported by the Copper Producers' Association:

Monthly deliveries of copper for domestic consumption and for export in 1912 as reported by the Copper Producers' Association, in pounds.

Month.	Domestic consumption.	Export.	Total.
January	62,343,901	80,167,904	142,511,805
February	56,228,368	63,148,096	119,376,464
March	67,487,466	58,779,566	126,267,032
April	69,513,846	53,252,326	122,766,172
May	72,702,277	69,485,945	142,188,222
June	66,146,229	61,449,650	127,595,879
July	71,094,381	60,121,331	131,215,712
August	78,722,418	70,485,150	149,207,568
September	63,460,810	60,264,796	123,725,606
October	84,104,734	47,621,342	131,726,076
November	69,369,795	55,906,550	125,276,345
December	58,491,723	65,713,796	124,205,519
Total	819,665,948	746,396,452	1,566,062,400

USES.

No systematic attempt has been made to ascertain the proportion of the copper output of 1912 used in different industries, as electric transmission, brass manufacture, casting, etc. Some idea of the quantities entering the different industries can be gained from the forms in which the output of the refineries was cast. The following table shows the approximate quantity of copper cast in the different forms during 1912 as reported by the refining companies. It will be noted that the total is not the same as the refinery output for 1912.

Forms in which copper was cast in 1912, in pounds.

Form.	Total.	Percentage.
Wire bars	823,758,012	54
Ingots and ingot bars	338,358,947	22
Cakes	117,418,022	8
Cathodes	212,447,514	14
Other forms	41,229,626	2
Total	1,533,212,121	100

It may be assumed that a large portion of the 54 per cent cast as wire bars was used for electrical purposes and that the 8 per cent cast as cakes was used largely for rolling. The other forms are less easily classified. The 14 per cent cast as cathodes, together with a portion of the ingots, probably entered the brass industry, and a large quantity of copper ingots was used in casting. The refinery output for 1911 was cast as follows: Wire bars, 50 per cent; ingots, 29 per cent; cakes, 10 per cent; cathodes, 9 per cent; other forms, 2 per cent.

PRICES.

The average yearly quoted price of electrolytic copper at New York in 1912 was about 16.48 cents per pound; in 1911 the price was 12.55 cents per pound. The average monthly prices for electrolytic copper in 1910, 1911, and 1912, as reported in "Metal statistics" American Metal Market Co., are given in the following table:

Average monthly prices at New York per pound of copper in 1910, 1911, and 1912, in cents.

Month.	Price of electrolytic copper, in cents.		
	1910	1911	1912
January	13.620	12.53	14.27
February	13.332	12.48	14.26
March	13.255	12.31	14.78
April	12.733	12.155	15.85
May	12.550	12.13	16.16
June	12.404	12.55	17.29
July	12.215	12.625	17.35
August	12.490	12.575	17.60
September	12.379	12.39	17.67
October	12.553	12.36	17.60
November	12.742	12.77	17.49
December	12.581	13.71	17.505
Average	12.738	12.55	16.48

The average yearly price of Lake copper was 16.58 cents. The New York quotations are the basis on which copper is sold by the mines to custom smelters and are used by the United States Geological Survey in calculating the value of both mine and smelter output. It is well known, however, that this average yearly price only approximates the actual average price received for copper sold during the year.

The average selling price received by several large producers of electrolytic copper, as given in their annual reports, varies from 15.51 cents to 16.58 cents, with an average of 15.77 cents, which indicates that the average as indicated by the quotations was considerably above the actual average price realized by producers.

In the case of Lake mines the average price received by companies reporting was 16.44 cents per pound

WORLD'S PRODUCTION.

The smelter production of copper in the world was 2,251,311,770 pounds in 1912, as compared with 1,954,957,560 pounds in 1911. In 1912 the smelter output of the United States was 55 per cent of the world's production, as compared with 56 per cent in 1911.

The following table shows the world's production by countries. The figures are those compiled by Henry R. Merton & Co. (Ltd.), reduced to pounds, except that the official figures for the production of the United States and Canada are inserted.

World's production (smelter output) of copper in 1911 and 1912, by countries, in pounds.

Producing country.	1911	1912
United States	1,097,232,749	1,243,268,720
Mexico	121,072,000	158,760,000
Japan	123,200,000	146,853,000
Spain and Portugal	123,200,000	131,175,450
Australia	99,904,000	105,399,000
Chile	66,304,000	83,569,500
Canada	55,648,011	77,775,600
Russia	57,120,000	73,867,500
Germany	68,320,000	53,581,500
Peru	58,240,000	60,858,000
Sweden and Norway	21,280,000	25,578,000
Cape Colony	15,680,000	14,112,000
Servia	.....	16,317,000
German Southwest Africa and other Africa	.....	22,491,000
Austria-Hungary	5,644,800	8,820,000
Italy	6,720,000	5,071,500
Bolivia	5,600,000	8,158,500
Newfoundland	2,645,520	1,102,500
Turkey	1,568,000	1,102,500
Cuba	8,377,480	8,820,000
Miscellaneous	23,520,000	4,630,500
Total	1,961,276,560	2,251,311,770

LEAD.

By C. E. Siebenthal.

INTRODUCTION.

An estimate of the production of refined lead in 1912 was given out in the form of a press bulletin on January 2, 1913. This was based on reports from every smelter, giving the actual production for the first 10 or 11 months of 1912, with estimates for the remainder of the year. The total thus obtained was very nearly identical with the final figures of production, being 71 tons in excess of those figures. The complete figures of production and consumption of primary[1] refined lead and of imports and exports of lead in ore and bullion were given in the advance statement of lead production, which was published March 14, 1913. The present report contains, in addition, tables and curves showing the production, consumption, imports, exports, and prices for a period of years, a comparison of the mine and the smelter production of lead by States, a list of lead smelters, and a summary of metallurgical advance in 1912.

The statistics of production of lead in this country in 1912 have been compiled by the United States Geological Survey from confidential reports by each lead-smelting company in operation during the year. The statistics of the recovery of secondary lead were also collected by the United States Geological Survey. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and the tables for foreign production and consumption were compiled from the sources indicated.

STATE OF LEAD INDUSTRY IN 1912.

The production of primary lead from domestic ores in 1912 was 415,395 short tons, valued at $37,385,550, based on the average New York price, as compared with 405,863 short tons, valued at $36,527,670, based on the average New York price, in 1911, a gain of 9,532 tons, equal to 2.35 per cent, in quantity and of $857,880, equal to 2.35 per cent, in value.

The lead-smelting industry of the United States did not fully share the general prosperity of the metal industries during 1912. Though the price of lead at London rose to the highest point in 30 years, in fact the highest point ever reached in that market, and averaged nearly a cent per pound higher than in 1911, the average New York

[1] By primary lead is meant lead which has been produced directly from ore. This term is used for purposes of distinction from secondary lead, which is obtained by refining skimmings, drosses, old metals, etc., figures for the production of which are given on a later page. Wherever in this report the word "lead" is used without qualification primary lead is to be understood.

price was the same as in the preceding year. As a result the total production of primary refined lead slightly decreased, though the domestic production more than held its own. The chief source of loss was in lead refined from foreign base bullion, and this was doubtless due to the interruption of operations at smelters in Mexico by the civil war in that country.

The largest gain in production was made by Idaho with 10,445 tons, a 9 per cent increase. Colorado had the next largest gain with 6,597 tons, or 22 per cent. Utah, Nevada, and New Mexico followed in order with gains of 5,731 tons, 4,617 tons, and 1,140 tons respectively. Nevada's gain was the largest in proportion, the production for 1912 being over four times that of the former year. Missouri had the greatest loss, nearly 20,000 tons, or about 11 per cent, but notwithstanding this loss the State retained first place in point of production, being credited by the smelters with over 39 per cent of the total lead production of the United States. The general gain by Western States and the losses in output sustained by the Mississippi Valley States increase the production of argentiferous lead as compared to nonargentiferous lead, the percentage of the latter being 44 in 1912, whereas it was 49 in 1911.

As has been true for several years, certain important producers were unwilling to report stocks of lead on hand at the close of the year, so that it is not possible to state accurately the deliveries to consumption. As the next best thing, the lead available for consumption is calculated from the domestic production, together with imports, exports, and stocks of foreign lead in bonded warehouse.

PRODUCTION.

PRODUCTION, 1825–1912.

The production of lead in the United States since 1825 from domestic ores and from foreign ores and base bullion is shown in the table following. For the early years, in the absence of official records, the figures have been compiled from the best available sources. The figures for the period from 1825 to 1853 are those published by Whitney; those for the later years were collected by E. A. Caswell. Totals for 1882 were compiled from statistics gathered by the Census Bureau. Since 1882 the figures have been annually collected by the United States Geological Survey.

According to Hahn,[1] argentiferous-lead ore was smelted in Montana and Nevada as early as 1866–67, but for the silver only, as the value of the lead would not pay transportation charges to market. With the completion of the Union Pacific Railroad in 1869 and the development of the mines at Eureka, Nev., the production of lead bullion began. The first figures of this production which are available are for 1873. It is evident from the totals for 1871 and 1872 that not much bullion was produced before 1873. Estimates have been made for these years, as well as for 1874, in order to arrive at totals for the different classes of lead. Foreign bullion, principally from Mexico, began in 1891 to be imported into this country for refining, but before 1906 the annual quantities so imported were not

[1] Mineral Resources U. S. for 1882, U. S. Geol. Survey, 1883, p. 324.

distinguished in the statistical record of general imports from the lead imported in ore. Since the soft lead is all domestic, the desilverized lead of domestic origin can be readily found by subtracting the total lead of foreign origin from the total desilverized-lead production of that year, or by subtracting the soft lead from the total domestic lead of that year. Prior to 1906 the total production of antimonial lead was included in the production of refined, desilverized lead, but since that date it has been excluded.

Production of refined lead in the United States, 1825–1912, in short tons.

Year.	Antimonial lead.[a]	Desilverized lead.[b]	Soft lead.[c]	Total production.[b]	From domestic ores and base bullion.[b]	From foreign ores.[d]	From foreign base bullion.[e]
1825–1868	.....	.....	676,200	676,200	676,200	.....	.....
1869	.....	.....	17,500	17,500	17,500	.....	.....
1870	.....	.....	17,830	17,830	17,830	.....	.....
1871	.....	f 1,000	f 19,000	20,000	20,000	.....	.....
1872	.....	f 5,380	f 20,500	25,880	25,880	.....	.....
1873	.....	20,159	22,381	42,540	42,540	.....	.....
1874	.....	f 28,524	f 23,556	52,080	52,080	.....	.....
1875	.....	34,909	24,731	59,640	59,640	.....	.....
1876	.....	37,649	26,421	64,070	64,070	.....	.....
1877	.....	50,748	31,152	81,900	81,900	.....	.....
1878	.....	64,290	26,770	91,060	91,060	.....	.....
1879	.....	64,650	28,130	92,780	92,780	.....	.....
1880	.....	70,135	27,690	97,825	97,825	.....	.....
1881	.....	86,315	30,770	117,085	117,085	.....	.....
1882	.....	103,875	29,015	132,890	132,890	.....	.....
1883	.....	122,157	21,800	143,957	143,957	.....	.....
1884	.....	119,965	19,932	139,897	139,897	.....	.....
1885	.....	107,437	21,975	129,412	129,412	.....	.....
1886	.....	114,829	20,800	135,629	130,629	5,000	.....
1887	.....	135,552	25,148	160,700	145,700	15,000	.....
1888	.....	151,465	29,090	180,555	151,919	28,636	.....
1889	.....	153,709	29,258	182,967	156,397	26,570	.....
1890	.....	130,403	31,351	161,754	143,630	18,124	.....
1891	a 4,043	171,009	31,397	202,406	178,554	23,852	.....
1892	a 5,039	181,584	31,678	213,262	173,305	39,957	.....
1893	a 5,013	196,820	32,513	229,333	163,982	65,351	.....
1894	.....	181,404	37,686	219,090	159,351	59,739	.....
1895	.....	201,992	39,890	241,882	165,709	76,173	.....
1896	a 7,507	221,457	43,537	264,994	187,256	77,738	.....
1897	a 8,867	247,483	43,553	291,036	207,365	83,671	.....
1898	a 8,473	267,842	42,779	310,621	210,676	99,945	.....
1899	a 6,345	263,826	40,566	304,392	208,466	95,926	.....
1900	a 9,906	329,658	48,021	377,679	270,824	106,855	.....
1901	a 10,656	323,790	57,898	381,688	269,266	112,422	.....
1902	a 9,169	303,011	74,050	377,061	276,455	100,606	.....
1903	a 9,579	295,074	83,444	378,518	290,194	88,324	.....
1904	a 11,001	315,284	89,169	404,453	308,603	95,850	.....
1905	a 10,995	313,847	85,455	399,302	318,509	80,793	.....
1906	10,546	313,886	90,860	404,746	336,200	28,803	39,743
1907	9,910	313,588	99,801	413,389	352,381	24,041	36,967
1908	13,629	295,552	101,012	396,564	311,666	11,509	73,389
1909	12,896	329,751	117,158	446,901	352,839	21,754	72,316
1910	14,069	328,954	141,318	470,272	375,402	18,065	76,805
1911	14,078	331,032	155,947	486,979	391,995	10,764	84,220
1912	13,552	339,646	141,248	480,894	392,517	11,572	76,805
Total	.....	7,669,641	2,849,980	10,519,613	8,632,336	1,887,285	

[a] Included also under desilverized lead and total production prior to 1906.
[b] Including also antimonial lead, except for 1906–1912, inclusive.
[c] Desilverized soft lead is excluded.
[d] Including also lead from foreign base bullion for 1891–1905, inclusive.
[e] Included in lead from foreign ore prior to 1906.
[f] Estimated.

PRODUCTION CURVES.

The curves in figure 4 show graphically the total domestic lead production from 1830 to the present, the production of soft lead from 1830 to 1912, and the production of desilverized lead since the beginning of that industry. In order to obtain a curve for the total

production of soft lead, both plain and desilverized, the quantities of soft lead annually desilverized have been added to the output of the soft-lead smelters. Since there is no record of the desilverized soft lead prior to 1894, a portion of the curve representing the total production of soft lead is hypothetical, as indicated by a broken line. The curve representing the production of desilverized lead was obtained by taking the difference between the plain soft-lead curve and the curve of total lead production.

Perhaps the most striking fact brought out by the curve is that practically all the gain in domestic lead output in the last six years has been made in the production of soft lead. This is the graphic

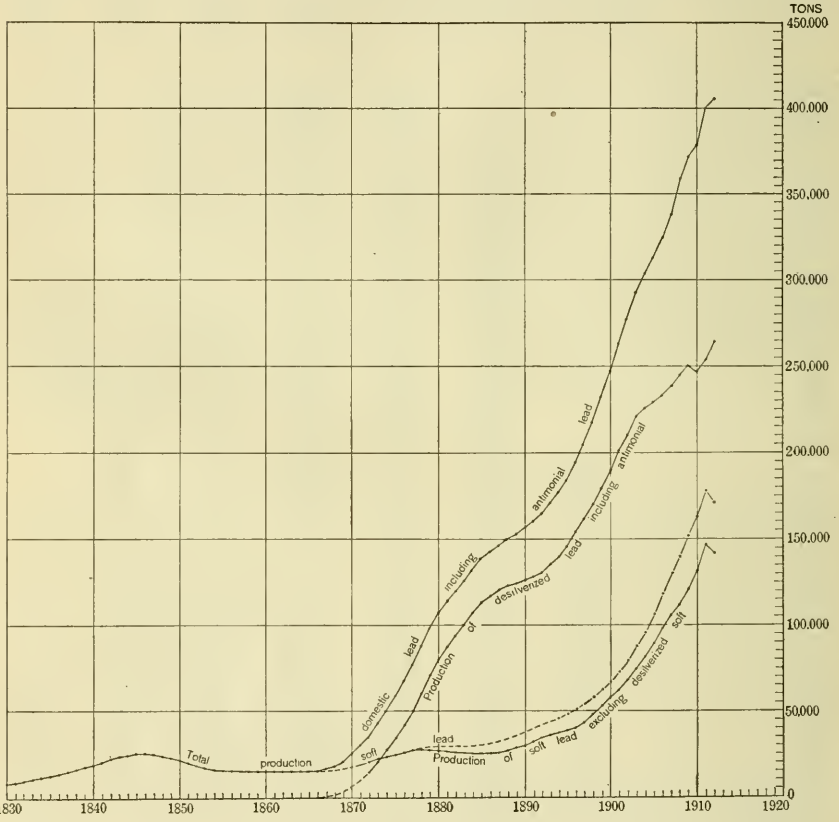

FIGURE 4.—Diagram showing domestic lead production in the United States, 1830–1912.

representation of the fact brought out by the production tables that the western lead-producing States have remained practically stationary in output in recent years, while the southeast Missouri lead region has made great gains.

These curves have been derived by taking nine-year averages. That is, each point in the curve representing a year is the average of that year as well as of the four years preceding and of the four years following, except near the ends of the curve, where the number of adjacent years included in the average is necessarily fewer. This method practically eliminates the yearly vicissitudes of production and yields a natural curve of the periodic trend of the industry.

PRODUCTION BY STATES.

The following table showing the production of lead by States is taken, with the exceptions indicated, from two sources which in themselves involve somewhat different methods of compilation. The figures for years prior to 1894 are from the trade statistics of E. A. Caswell and are in terms of refined lead. Compiled from reports by smelters and transportation companies, they probably represent to a certain extent the locality where smelted rather than that of the origin of the ore, but for the period involved these two items must have nearly coincided. For the years 1894 to 1905, inclusive, the figures have been collected by the United States Geological Survey. They were compiled from smelter reports and it should be noted that they represent the content of the ores and not the actual recovery, which is the quantity available for consumption. The latter quantity, termed "merchant lead," may be estimated from the figures of lead content by deducting therefrom a proper allowance for losses in smelting, desilverizing, and refining.

Production of lead by States, 1873–1905, in short tons.

Year.	Argentiferous lead.										Mississippi Valley soft lead.		
	Colorado.	Utah.	Montana.	Idaho.	California.	Arizona.	New Mexico.	Washington.	Nevada.	Other Western States.	Missouri-Kansas.	Southeast Missouri.	Wisconsin-Illinois.
1873	56	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,045	.....	7,336
1874	312	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,400
1875	818	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,099		5,600
1876	667	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,225		7,196
1877	897	24,194	2,912	.....	3,918	.....	.....	.....	19,724	(a)	15,422	9,312	6,418
1878	5,824	21,627	456	.....	4,320	.....	.....	.....	31,063	(a)	11,761	10,517	4,492
1879	22,783	14,370	2,431	.....	2,251	.....	.....	.....	22,805	(a)	14,182	11,158	2,800
1880	34,240	15,214	1,922	.....	2,100	.....	.....	.....	16,659	(a)	15,780	7,970	3,940
1881	42,516	23,973	3,360	.....	3,340	.....	.....	.....	12,826	(a)		30,770	
1882	60,988	29,947	.....	.....	.....	.....	.....	.....	8,590	3,700		29,015	
1883	70,800	33,330	.....	.....	.....	.....	.....	.....	5,775	15,840		21,600	
1884	72,600	30,432	7,470	.....	.....	.....	.....	.....	.....	14,718		18,140	
1885	53,500	29,160	10,993	.....	.....	.....	.....	.....	.....	20,600		21,265	
1886	48,480	24,332	12,632	.....	.....	.....	.....	.....	.....	19,500		22,460	
1887	55,722	22,900	16,000	.....	.....	.....	.....	.....	.....	22,400		27,958	
1888	56,916	22,283	31,400	.....	.....	.....	.....	.....	.....	15,201		31,252	
1889	54,288	31,180	28,400	.....	.....	.....	.....	.....	.....	13,709		27,400	
1890	51,450	34,132	18,300	.....	.....	.....	.....	.....	.....	10,664		33,840	
1891	58,950	43,360	28,000	.....	.....	.....	.....	.....	.....	20,168		29,763	
1892	48,400	45,553	32,600	.....	.....	.....	.....	.....	.....	21,527		32,895	
1893	46,800	35,043	20,045	.....	.....	.....	.....	.....	.....	24,900		32,859	
1894	50,613	23,190	9,637	33,308	478	1,480	2,973	.....	2,254	150		46,300	
1895	46,984	31,305	9,802	31,638	949	2,053	3,040	.....	2,583	381		53,596	
1896	44,803	35,578	11,070	46,662	691	1,165	3,461	.....	1,173	1,006		51,887	
1897	40,576	40,537	12,930	58,627	383	2,184	9,123	.....	959	638		56,542	
1898	57,352	39,299	10,745	59,142	482	2,224	5,797	.....	4,714	1,349		54,469	
1899	70,308	29,987	10,227	52,154	487	3,377	4,856	.....	3,388	862		54,444	
1900	82,137	48,044	.....	85,444	520	.....	.....	.....	.....	.....		.....	
1901	73,265	49,870	5,791	79,654	381	4,045	1,124	.....	1,873	1,029		67,172	
1902	51,833	53,914	4,438	84,742	175	599	741	1,457	1,269	2,184		79,445	
1903	45,554	51,129	3,303	99,590	55	1,493	613	538	2,237	1,765		86,597	
1904	51,884	56,470	3,635	108,854	163	1,499	1,363	622	1,873	41		92,275	
1905	56,638	44,996	2,207	99,027	116	2,091	1,232	56	2,206	101		104,058	

a Included under Montana.

The closer distribution of the lead production among the States from which the ore was derived, which was begun in 1906, has necessitated the separate table which follows. The product of refined lead can with difficulty be apportioned according to sources of ore, owing to the fact that lead refiners treat smelted products whose origin may,

as in custom refining, be unknown to them, the identity of the ore and thus its original source being preserved only as far as the smelter. Accordingly, this table, showing sources of lead smelted or refined in the United States, is based as far as possible on smelter figures. It includes "pig lead" reported by all known smelters running on Mississippi Valley or southern lead ores, and "lead" produced at all other lead smelters in this country. The greater part of the product reported by smelters operated in conjunction with refineries is in terms of refined lead. A like part of the antimonial lead product is thus eliminated from the "lead" produced and appears only in the figures of production of antimonial lead. No lead ore from the United States was treated elsewhere during the period covered by the table.

Sources of primary lead smelted or refined in the United States, 1906–1912, in short tons.

Source of ore.	1906	1907	1908	1909	1910	1911	1912
	Quantity.	Quantity.	Quantity.	Quantity.	Quantity.	Quantity.	Quantity.
Domestic ore:							
Alaska	8	.....	3	69	75	51	45
Arizona	2,884	2,418	1,464	1,507	948	3,428	3,891
Arkansas	.....	15	.....	14	.....	15	.....
California	432	938	515	977	1,207	615	811
Colorado	50,497	52,552	28,729	30,865	38,542	30,442	37,039
Idaho	117,117	123,292	98,464	103,747	109,951	117,335	127,780
Illinois	572	498	362	273	263	308	513
Iowa	270	225	110	15	.....	.....	.....
Kansas	1,932	1,798	2,293	2,763	1,308	2,522	1,937
Kentucky	44	75	.....	.....	50	.....	91
Missouri	111,075	122,856	122,451	141,105	161,659	182,203	162,610
Montana	2,485	2,145	2,320	1,451	1,943	2,484	2,517
Nevada	1,669	3,480	3,796	4,792	2,246	1,082	5,699
New Mexico	640	2,047	586	1,350	1,890	1,371	2,511
North Carolina	.....	.....	.....	.....	2	35	34
Oklahoma	.....	404	1,409	2,268	1,805	1,925	2,500
Oregon	.....	5	7	7	.....	11	21
South Dakota	.....	.....	13	.....	8	33	12
Tennessee	11	16	.....	.....	.....	.....	.....
Texas	25	12	42	44	36	57	30
Utah	56,260	55,540	42,455	66,648	60,605	54,933	60,664
Virginia	.....	83	13	.....	87	400	85
Washington	46	341	391	120	339	612	53
Wisconsin	1,753	3,573	4,013	3,252	3,909	3,966	3,301
Undistributed	380	896	36	317	101	48	120
Zinc residues	2,053	1,890	1,290	1,735	2,237	1,987	3,131
Total from domestic ore	350,153	375,099	310,762	363,319	389,211	405,863	415,395
Foreign ore:							
Africa	.....	288	.....	3,150	3,310	582	1,774
Canada	7,238	2,607	162	66	25	122	29
Central America	112	23	12	20	3	28	.....
Mexico	21,435	20,204	10,145	16,944	11,704	7,333	7,407
South America	.....	919	1,186	1,536	2,996	2,677	2,332
Other foreign	18	.....	4	38	27	22	30
Foreign base bullion:							
Canada	.....	2,716	179	1,500	.....	.....	.....
Mexico	39,743	34,251	73,210	70,816	76,805	84,220	76,805
Total from foreign ore and base bullion	68,546	61,008	84,898	94,070	94,870	94,984	88,377
Grand total, derived from all sources	418,699	436,107	395,660	457,389	484,081	500,847	503,772

SOFT LEAD.

The lead ores of the Mississippi Valley are almost free from silver, and the lead produced from them is known as "soft lead." A little

lead ore derived from Washington and other Western States is also of this character. All but one of the smelters running exclusively on these soft-lead ores do not desilverize their product. Their output is shown in the "soft-lead" column of the general table of refined lead production for 1825–1912, which is given on a preceding page. However, considerable quantities of the soft-lead ores have been annually smelted by the silver-lead smelters, and, in addition, since 1904 one of the Mississippi Valley smelters has regularly desilverized its product. This desilverized soft lead, for the years prior to 1906, has not been kept separate from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted has been recorded since 1894. Since 1906 the quantity of soft lead produced by each State has been recorded, as shown in the tables below. In the table immediately following, the output of the soft-lead smelters is given in the first column, and the lead content of soft-lead ores smelted and desilverized is given in the second column. For the years 1904 and 1905 a portion of the quantity given in the second column represents lead content of ore, and a portion is refined lead. From 1906 to the present the only quantity given is that of refined lead.

In order to give a fair notion of the annual quantity of refined pig lead recovered from soft-lead ores, the lead recovered from such ores by the silver-lead smelters has been estimated at the rate of recovery used in the official reports for those years. Even so, the figures do not give the total quantity of lead recovered from soft-lead ores. To give the total recovered soft lead there must be taken into account the lead recovered in the form of pigments, as these are made from soft-lead ores. On this basis the soft lead recovered in 1912 constituted 44 per cent of the total domestic refined lead production, as compared with 49 per cent in 1911.

Production of soft lead in the United States, 1894–1912, in short tons.

Year.	Undesilverized.	Desilverized.		Total soft lead.
		Lead contents of ore.	Recovered lead.	
1894	37,686	[a] 8,614	[b] 8,097	[b] 45,783
1895	39,890	[a] 13,706	[b] 12,884	[b] 52,774
1896	43,537	[a] 8,350	[b] 7,849	[b] 51,386
1897	43,553	[a] 12,989	[b] 12,210	[b] 55,763
1898	42,779	[a] 11,688	[b] 10,987	[b] 53,766
1899	40,566	[a] 13,878	[b] 13,045	[b] 53,611
1900	48,021	[a] 11,500	[b] 10,810	[b] 58,831
1901	57,898	[a] 9,274	[b] 8,718	[b] 66,616
1902	74,050	[a] 5,395	[b] 5,071	[b] 79,121
1903	83,444	[a] 3,153	[b] 2,961	[b] 86,408
1904	89,169	[c] 5,320	[b] 5,165	[b] 94,334
1905	85,455	[c] 18,603	[b] 18,556	[b] 104,011
1906	90,860	.....	25,000	115,860
1907	99,801	.....	29,829	129,630
1908	101,012	.....	29,869	130,881
1909	117,158	.....	32,532	149,690
1910	141,318	.....	27,952	169,270
1911	155,947	.....	35,667	191,614
1912	141,248	.....	29,789	171,037

[a] Lead content of ores smelted and desilverized.
[b] Estimated recovery of lead from lead content of ore.
[c] In part lead content of ores, in part refined lead.

The table below shows the production of soft pig lead, by States, for the period 1906–1912, which is as far back as the records of the individual production of the Mississippi Valley States are available. The figures include both plain and desilverized soft lead, but do not include the lead content of pigments.

Production of soft pig lead in the United States in 1906–1912, by States, in short tons.

Source of ore.	1906	1907	1908	1909	1910	1911	1912
Arkansas	.....	15	.....	14	.....	15	.....
Illinois	572	498	362	273	263	308	513
Iowa	270	225	110	15	.....	.....	.....
Kansas	1,932	1,798	2,293	2,763	1,308	2,522	1,937
Kentucky	44	75	.....	.....	50	.....	91
Missouri	111,075	122,856	122,451	141,105	161,659	182,203	162,610
Oklahoma	.....	404	1,409	2,268	1,805	1,925	2,500
Tennessee	11	16	.....	.....	.....	.....	.....
Virginia	.....	83	13	.....	87	400	85
Washington	19	87	230	.....	189	275	.....
Wisconsin	1,753	3,573	4,013	3,252	3,909	3,966	3,301
Undistributed	184	.....	.....	.....	.....	.....	.....
Total	115,860	129,630	130,881	149,690	169,270	191,614	171,037

ANTIMONIAL LEAD.

The production of antimonial lead from ores derived from all sources, as reported by all desilverizers operating in this country, is shown in the following table:

Production of antimonial lead in the United States from 1891 to 1912, in short tons.

1891	4,043	1902	9,169
1892	5,039	1903	9,579
1893	5,013	1904	11,001
1894	-----	1905	10,995
1895	-----	1906	10,546
1896	7,507	1907	9,910
1897	8,867	1908	13,629
1898	8,473	1909	12,896
1899	6,345	1910	14,069
1900	9,906	1911	14,078
1901	10,656	1912	13,552

Production of antimonial lead in the United States, 1907–1912, in short tons.

Year.	From domestic ore.	From foreign ore.	Total.	Value.	Antimony content.	Lead content.
1907	.....	.....	9,910	$1,322,985	1,561	8,349
1908	.....	.....	13,629	1,264,771	2,440	11,189
1909	8,889	4,007	12,896	1,231,019	2,360	10,536
1910	10,140	3,929	14,069	1,338,090	2,229	11,840
1911	9,636	4,442	14,078	1,380,556	2,254	11,824
1912	8,549	5,003	13,552	1,311,348	1,949	11,603
Average composition, by percentage	.....	.....	.....	.....	14.4	85.6

For further details of the production and consumption of antimony in the United States, the reader is referred to the chapter on antimony in this volume.

LEAD PIGMENTS.

In addition to the leaded zinc oxide and zinc-lead oxide pigments, which are noted more particularly in connection with the production of zinc pigments, there are two lead pigments which are produced directly from ore, namely, sublimed white lead and sublimed blue lead. Sublimed white lead consists of lead sulphate 75 per cent, lead oxide 20 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, with small proportions of lead sulphide, lead sulphite, and zinc oxide. Zinc-lead oxide contains from 46 to 50 per cent of lead sulphate, from 52 to 46 per cent of zinc oxide, and a small amount of zinc sulphate. Leaded zinc oxide may vary from 4 to 20 per cent in lead sulphate, the remainder being zinc oxide, with a small portion of zinc sulphate.

The total lead content of the production in 1912 from domestic ores of the above-mentioned pigments was 10,323 short tons, as compared with 7,678 tons in 1911, with 7,603 tons in 1910, with 7,292 tons in 1909, with 7,377 tons in 1908, and with 6,574 tons in 1907.

SECONDARY LEAD.

Important sources of lead are skimmings, drosses, old metal, and alloys, as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral portion of the lead industry. This business is mostly carried on at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. In such cases it has been noted on the reports of the smelters to the Survey, and to that extent the production of secondary lead has always been taken into account. Since 1907, however, statistics have been collected from the secondary refineries, for the first two years by the writer, and for the last four years by J. P. Dunlop, of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged and the number of firms reporting was increased from 44 to over 100, with the result that the figures of production for later years show a great increase. The product of such secondary refineries is of two classes—pig lead and lead in alloys. In the latter case the lead may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by addition of the requisite metal.

Production of secondary lead in the United States, 1907–1912, in short tons.

	1907	1908	1909	1910	1911	1912
Pig lead	10,153	7,858	18,360	29,492	27,389	30,266
Lead in alloys	15,508	10,543	23,327	25,930	26,895	36,902
Total recovered lead	25,661	18,401	41,687	55,422	54,284	67,168

COMPARISON OF STATE TOTALS BASED ON SMELTER RETURNS AND ON MINE REPORTS.

The foregoing figures of the production of metallic lead by the respective States are compiled from reports of individual lead smelters and refineries. For several years the production of the more valuable metals in the Western States has been obtained by the Survey from reports of individual mines. In 1906 the same method was followed in the Eastern States, and in 1907 the plan was extended to take in the whole country. In order to put the smelter production on the same basis as the mine figures, all the lead which was produced as pigments directly from ore is added to the production of metallic lead. The lead recovered from secondary sources is excluded from these totals, since it has already been reckoned once as pig lead. These facts must be borne in mind in comparing this table with the preceding tables. The State totals obtained by each method for the last six years are compared in the following table:

Comparison of State totals compiled from smelter and mine returns, 1907–1912, in short tons.

State.	1907				1908			
	Totals based on smelter reports.	Totals based on mine reports.	Differences.		Totals based on smelter reports.	Totals based on mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Alaska					3		3	
Arizona	2,428	2,330	98		1,464	1,504		40
Arkansas	15	12	3			15		15
California	938	1,313		375	515	619		104
Colorado	54,272	42,703	11,569		30,853	26,100	4,753	
Idaho	123,292	116,912	6,380		98,464	103,414		4,950
Illinois	509	830		321	362	399		37
Iowa	225	242		17	110	51	59	
Kansas	1,929	2,555		626	2,825	2,518	307	
Kentucky	75	34	41					
Missouri	127,373	138,675		11,302	127,620	144,459		16,839
Montana	2,145	1,874	271		2,320	2,298	22	
Nevada	3,480	3,136	344		3,796	3,623	173	
New Mexico	2,246	1,905	341		586	437	149	
Oklahoma	476	532		56	1,576	1,781		205
Oregon	5		5		7	1	6	
South Dakota					13	12	1	
Tennessee	16		16					
Texas	12	12			42	33	9	
Utah	55,914	57,969		2,055	42,455	44,389		1,934
Virginia	83	[a] 70	13		13	38		25
Washington	406	410		4	593	575	18	
Wisconsin	3,573	3,499	74		4,097	4,138		41
Undistributed	896		896		36		36	
Zinc residues	1,890		1,890		1,290		1,290	
Total	382,198	375,013			319,040	336,404		

[a] Includes also production of Georgia and New Hampshire.

Comparison of State totals compiled from smelter and mine returns, 1907–1912, in short tons—Continued.

State.	1909				1910			
	Totals based on smelter reports.	Totals based on mine reports.	Differences.		Totals based on smelter reports.	Totals based on mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Alaska	69	19	50	.....	75	28	47	.....
Arizona	1,507	1,549	.....	42	948	1,348	.....	400
Arkansas	14	24	.....	10	.....	63	.....	63
California	977	751	226	.....	1,207	1,435	.....	228
Colorado	32,451	36,084	.....	3,633	39,864	38,036	1,828	.....
Idaho	103,747	107,993	.....	4,246	109,951	114,129	.....	4,178
Illinois	273	295	.....	22	263	373	.....	110
Iowa	15	36	.....	21	.....	20	.....	20
Kansas	3,084	1,300	1,784	.....	1,581	2,412	.....	831
Kentucky	.....	10	.....	10	50	41	9	.....
Missouri	145,827	159,435	.....	13,608	166,298	161,016	5,282	.....
Montana	1,451	1,492	.....	41	1,943	2,053	.....	110
Nevada	4,792	4,920	.....	128	2,246	2,436	.....	190
New Mexico	1,350	2,515	.....	1,165	1,890	2,160	.....	270
North Carolina	.....	.....	.....	.....	2	.....	2	.....
Oklahoma	2,820	3,427	.....	607	2,612	2,888	.....	276
Oregon	7	.....	7	.....	.....	.....	.....	.....
South Dakota	.....	59	.....	59	8	7	1	.....
Texas	44	46	.....	2	36	33	3	.....
Utah	66,648	74,243	.....	7,595	60,605	61,662	.....	1,057
Virginia	.....	.....	.....	.....	87	99	.....	12
Washington	120	144	.....	24	339	661	.....	322
Wisconsin	3,363	3,694	.....	331	4,152	4,413	.....	261
Undistributed	317	.....	317	.....	101	.....	101	.....
Zinc residues	1,735	.....	1,735	.....	2,237	.....	2,237	.....
Total	370,611	398,036	.....	.....	396,495	395,313	.....	.....

State.	1911				1912			
	Totals based on smelter reports.	Totals based on mine reports.	Differences.		Totals based on smelter reports.	Totals based on mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Alaska	51	24	27	.....	45	.....	45	.....
Arizona	3,428	5,137	.....	1,709	3,891	3,403	488	.....
Arkansas	21	64	.....	43	.....	31	.....	31
California	615	699	.....	84	811	572	239	.....
Colorado	31,718	34,840	.....	3,122	39,348	37,621	727	.....
Idaho	117,335	136,278	.....	18,943	127,780	142,093	.....	14,313
Illinois	308	964	.....	656	513	1,282	.....	769
Iowa	.....	60	.....	60	.....	63	.....	63
Kansas	2,775	2,859	.....	84	2,187	2,371	.....	184
Kentucky	.....	.....	.....	.....	91	106	.....	15
Missouri	187,384	178,868	8,516	.....	168,483	177,069	.....	8,586
Montana	2,484	3,216	.....	732	2,518	3,723	.....	1,205
Nevada	1,082	1,632	.....	550	5,707	9,750	.....	4,043
New Mexico	1,371	1,483	.....	112	2,511	2,747	.....	236
North Carolina	35	.....	35	.....	34	46	.....	12
Oklahoma	2,553	2,501	52	.....	3,056	3,388	.....	332
Oregon	11	.....	11	.....	21	20	1	.....
South Dakota	33	32	1	.....	12	11	1	.....
Texas	57	61	.....	4	30	33	.....	3
Utah	55,070	68,248	.....	13,178	60,913	70,156	.....	9,243
Virginia	400	417	.....	17	85	235	.....	150
Washington	612	424	188	.....	53	64	.....	11
Wisconsin	4,163	3,353	810	.....	3,326	2,581	745	.....
Undistributed	48	.....	48	.....	120	.....	120	.....
Zinc residues	1,987	.....	1,987	.....	3,131	.....	3,131	.....
Total	413,541	441,160	.....	.....	424,666	457,365	.....	.....

The smelter totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total for that State. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter State totals, making allowance in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent discrepancies. The causes of these discrepancies fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter until the succeeding year and, unless balanced by an equivalent lag from the preceding year, will thus lead to an apparent "mine excess." Near the close of 1911 there were reports in the mining journals of the accumulation of 30,000 tons of lead ore at the Tooele smelter then under construction, but which did not blow in until 1912. The lead content of this ore appears as "mine excess" in the 1911 reports for the Western States furnishing the ore, notably Utah and Idaho. If through accident, business depression, or otherwise, the mines close down, the smelters largely consume their ore stocks, which results in an apparent "smelter excess." The second source of difference is found in error in the mine totals, either in ore tonnage or in the arbitrary calculation of metal content from assay. The dry assay in vogue in the Western States gives results uniformly too low. A decision of the United States circuit court (T. D. 21653) recognizes a differential of 1.5 per cent between the dry assay and chemical analysis, and in actual practice the discrepancy is probably even greater than that figure. A third source is found in failure of the smelter returns to segregate accurately the ore from the different States. Until 1906 the ore coming from the Joplin district was lumped by the smelters as from Missouri or Missouri-Kansas, though some of it was from Oklahoma. This tended to make a smelter excess for Missouri and a mine excess for Kansas and Oklahoma. The same custom was to a certain extent true of the upper Mississippi Valley district. Though apportioned to the proper States since 1906, the division is confessedly a rough estimate in the case of some of the smelters which do not keep the ore from these regions separate on their books. Lastly, there is not taken into account in these totals, except in certain of the Western States, the loss in smelting, ranging from 2 to 5 per cent in treating easily reducible ores and

up to 10 or more per cent in the more refractory ores. Losses running over 20 per cent have been claimed in smelting ores running high in antimony and arsenic. Lag being left out of account, each State would normally show a mine excess equal to this smelting loss. Any discrepancy which appears in the table may reasonably be ascribed to one or more of these items. In the long run, barring error and allowing for smelting losses and exportation of ore, the "mine excess" will be balanced by equivalent "smelter excess."

SMELTER AND MINE STATE TOTALS IN 1912.

As no allowance for smelting losses has been made in the mine totals, execept as noted, only those mine excesses which are notably above the normal loss in smelting need be discussed here. The smelter excess in Arizona probably represents depletion of smelter ore stocks from that State. The same cause accounts for the smelter excess in Colorado. The recurrent mine excesses in Idaho are partly accounted for by smelting losses, but there is also probably some lag in smelting. The mine excess in Illinois is balanced by an equivalent smelter excess in Wisconsin and both are probably due to error in distribution on the part of the smelters. The mine excess in Missouri is due in part to smelting losses and probably in part also to error in distribution by the smelter. The mine excess in Montana seems to be accounted for largely by lag, and this must be also true in Nevada, where the production made a great gain in 1912. The mine excess in Utah is partly explainable on the ground of lag in smelting and partly also by smelting losses.

RESOURCES.

MINE PRODUCTION OF LEAD IN UNITED STATES IN 1912.

The following table shows for each lead-producing State the total quantity of lead-bearing ores produced and the output of each kind of lead-bearing ore. The column headed "All other ores" includes copper ore, copper-lead ore, and dry or siliceous ore. "Dry" ores produced in Colorado contained 9,559 short tons of lead. This as in other States was concentrated from parts of the ore from certain counties, however, and was not distributed through the whole of the "All other ore" credited to Colorado. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each lead-producing State, so that a comparison may be made of the relative extent of deep mining operations in these States, the quantity of crude ore raised being the best measure for this purpose. As shown by the table, Missouri takes the same dominating position in the production of crude lead ore and lead-bearing zinc ores that was noted in the discussion of the table showing source of zinc mined in the United States in 1912 as given in the chapter on zinc in Mineral Resources. Missouri produced over one-fourth of the crude lead ore and over three-fourths of the crude lead-bearing zinc ore mined in the United States in 1912, and occupied the first rank in output of crude ore carrying any or all of the five metals named above.

The table also gives the quantity of lead contained in the crude ores of each State in 1912 and the lead content of each kind of lead-bearing ore. The percentage of lead contained in the lead ore, the lead-zinc ore, and the zinc ore of each State is also given. The lead content of lead ore ranged from 24.3 per cent in Washington down to 3.6 per cent in Missouri, the average for all the States being 5.5 per cent. The lead-zinc ores were somewhat less rich in lead than the lead ores, averaging 4.8 per cent. The average lead content of the zinc ores was 0.3 per cent, this low figure being due to the preponderance of low-grade lead-bearing zinc ores in the Central States. Of the total mine production of lead in 1912, a quantity corresponding to 77.2 per cent was derived from lead ores, 10.2 per cent was derived from lead-zinc ores, 9.1 per cent was derived from zinc ores, and 3.5 per cent was recovered from all other ores. The figures of mine production of lead are taken from the chapters on gold, silver, copper, lead, and zinc in the various States, as indicated in the prefatory note to this chapter.

Source of lead mined in the United States in 1912, by States and kinds of ore, in short tons.

State	Lead ores.			Lead-zinc ores.			Zinc ores.			All other ores.		Total.	
	Crude ore.	Lead content.	Percentage.	Crude ore.	Lead content.	Percentage.	Crude ore.	Lead content.	Percentage.	Crude ore.	Lead content.	Crude ore.	Lead content.
Arizona	20,960	2,278	10.9	4,190	659	15.7	22,321	293	1.3	6,792,611	173	6,840,082	3,403
Arkansas							32,755	31	.1			32,755	31
California	974	211	21.7				11,096	299	2.7	2,629,427	62	2,641,497	572
Colorado	182,745	14,820	8.1	229,107	11,421	5.0	177,946	618	.3	1,986,828	10,762	2,576,626	37,621
Idaho	1,597,661	125,387	7.8	480,126	16,681	3.5				188,547	25	2,266,334	142,093
Illinois							147,859	687	.5	(a)	595	a 147,859	1,282
Iowa	1,000	63	6.3									1,000	63
Kansas							744,254	2,371	.3			744,254	2,371
Kentucky	(a)	106										(a)	106
Missouri	4,064,366	146,861	3.6				9,321,145	30,208	.3			13,385,511	177,069
Montana	20,993	2,430	11.6	91	20	22.0	136,552	618	.5	5,394,528	655	5,552,164	3,723
Nevada	59,452	5,739	9.7	20,054	2,940	14.7	7,394			4,677,065	1,071	4,763,965	9,750
New Mexico	6,852	1,554	22.7	15,792	991	6.3	16,394	17	.1	1,313,248	185	1,352,286	2,747
North Carolina				1,215	46	3.8				14,858		16,073	46
Oklahoma							293,500	3,388	1.2			293,500	3,388
Oregon	23	2	8.7							90,922	18	90,945	20
South Dakota	267	11	4.1							1,901,459		1,901,726	11
Texas							351	5	1.4	20,757	28	21,108	33
Utah	498,401	53,489	10.7	216,764	13,881	6.4	9,422	313	3.3	7,045,683	2,473	7,770,270	70,156
Virginia				2,803	235	8.4	2,132			1,160		6,095	235
Washington	263	64	24.3							94,718		94,981	64
Wisconsin							1,363,636	2,581	.2			1,363,636	2,581
Total	6,453,957	353,015	5.5	970,142	46,874	4.8	12,286,757	41,429	.3	32,151,811	16,047	51,862,667	457,365
Percentage of total lead derived from each kind of ore.		77.2			10.2			9.1			3.5		100.0

a Tonnage of fluorspar from which lead was recovered as a by-product is not taken into account.

REVIEW BY DISTRICTS.

For details of production in the several lead-producing districts of the United States the reader is referred to the mine reports for the individual States appearing elsewhere in Mineral Resources for 1912. This review is based on those reports or on notes furnished by the authors of the various mine reports. Only the general trend of development during the year will be here considered in connection with the different districts.

EASTERN STATES.

In the Eastern States numerous veins of lead have been prospected and worked spasmodically, though in but three or four States have these operations developed into the caliber of lead mines.

In New York lead ore has been mined in quantity in the northern part of the State, in the Rossie district, and in the southern part of the State, near Ellenville, Wurtzboro, and Guymard. In 1911–12 a vein of lead ore near Gouverneur was prospected and a small shipment of sorted ore was made to the smelter. This resulted in the recovery of a small quantity of lead and a nominal quantity of gold and silver.

The Virginia lead ores have been known and mined for more than 150 years, the mines at Austinville being the oldest workings. Lead ore, associated with zinc, occurs at the Pulaski, Austinville, Cedar Valley, and Albemarle mines. The production of lead by Virginia mines in 1912 was 235 short tons, just a little more than half of the output in 1911.

In North Carolina lead ores have been mined in the Silver Hill district, Davidson County. The Washington mine, yielding argentiferous sulphides of zinc, lead, copper, and iron, was worked in 1836–1852 and some years thereafter to a depth of 650 feet. Other mines were worked later at Silver Valley and a smelter was erected at Thomasville, but there was no production from the State for about 25 years until the last three years, when zinc-lead sulphide ores from the Silver Hill district yielded 46 tons of lead in 1912 and smaller quantities in the two preceding years.

The lead ores of Tennessee are subordinate to the zinc ores, with which they generally occur. The New Prospect mine, in the Lead Mine Bend of Powell River, in Union County, has yielded both lead and zinc ores, but has not been worked for many years. The Blue Springs mine, 6 miles south of Cleveland, was operated for many years as a lead mine, though not lately. In the recently discovered zinc deposits at the old iron mines at Embreeville there are scattering masses of galena ore. These have been hand picked and stored, but no shipments have been made.

CENTRAL STATES.

The Kentucky-Illinois fluorspar region yields some lead ore, mostly obtained as concentrates in the reduction of crude fluorspar. The production of lead from this source has been unimportant in the last few years, owing to the depression in the fluorspar industry. The enlargement of fluorspar-concentrating plants in southern Illinois in 1911, together with the prosperous condition of the fluorspar

industry, led to an increase in the output of lead concentrates from that region, the total in 1912 being 595 tons. The production of lead in Kentucky was 106 tons.

The upper Mississippi Valley region, embracing adjoining portions of Wisconsin, Illinois, and Iowa, was the scene of some of the earliest lead mining in the United States. The mines were at first worked exclusively for lead, but since 1860 the production of zinc ore has predominated over that of lead ore, with which the zinc ore is associated in many mines. The lead content of lead concentrates produced in the district in 1912 was 3,330 short tons, as compared with 4,038 tons in 1911.

The southeast Missouri disseminated lead region has in recent years made the greatest gains in production of all the lead-producing districts of the United States, and since 1908 has annually exceeded the production of the Coeur d'Alene region, which formerly held first rank. The ore of the southeast Missouri region is almost wholly lead ore, although, particularly in the southern portion of the area, there is in many places considerable copper, nickel, and cobalt mixed with the lead. These occur in sufficient quantity to constitute the chief value of the ore in the North American mine at Fredericktown. An increasing quantity of zinc blende is also being found in the ore, ranging in the lead concentrates from a trace up to 5 per cent. Several of the milling plants remove the zinc as a table middling in concentration, and others similarly treat the copper-nickel-cobalt sulphides. The latter are salable, but no zinc recovered from the disseminated lead ore has been marketed. Silver also occurs in the ore to the extent of a little over 1 ounce to the ton of lead concentrates. The ore occurs in disseminated bodies of large size at depths ranging from 100 to 550 feet, though at a fairly definite geologic horizon. The crude ore in 1912 yielded 5.3 per cent of lead concentrates, which carried an average of 67.1 per cent of lead. The lead content of the lead ore mined in the southeast Missouri region in 1912, including also a small quantity from shallow lead mines in adjoining counties, was 146,913 short tons, as compared with 147,754 tons in 1911 and with 131,499 tons in 1910.

The production in 1912 was practically the output of six companies in St. Francois and Madison counties. Of three other companies in Madison County, two—the North American and the Hudson Valley or Phoenix—were in financial difficulties and made no production; the third—the Madison Lead & Land Co.—leased the Catherine mine and mill to the Federal Lead Co. The St. Louis Smelting & Refining Co. relinquished its lease of the Potosi Lead Co.'s mine near Leadwood and the mine was operated by the owners, the ore being concentrated on custom contract. The property of the Mine La Motte Lead & Smelting Co. was taken over on a 10-year lease by the St. Louis Smelting & Refining Co., as reported, at 10 per cent royalty, with privilege of purchase for $800,000.

The Joplin region includes southwest Missouri, southeast Kansas, and northeast Oklahoma. This is the greatest zinc-producing area in the United States and furnished 40 per cent of the total recoverable zinc production of 1912. The lead is practically all recovered as a by-product in concentrating the zinc ores. The lead content of the lead concentrates produced in the Joplin region in 1912 was 35,915 short tons, as compared with 36,474 tons in 1911 and with

34,817 tons in 1910. The lead content of lead concentrates produced in southwest Missouri in 1912 was 30,156 tons, as compared with 31,114 tons in 1911. Kansas likewise fell off slightly in lead output, but Oklahoma gained more than one-third over the production of 1911.

North Arkansas made a small quantity of lead concentrates, about half as much as in 1911, in milling zinc ores.

WESTERN STATES.

New Mexico's lead output nearly doubled in 1912, the figures being 2,747 short tons as against 1,483 tons in 1911. This output was derived from three counties, Grant and Socorro counties yielding nearly equal quantities, with a much smaller output from Luna County.

The production of lead in Colorado increased from 34,840 tons in 1911 to 37,621 tons in 1912. Lake County ranked first, and was followed by San Juan, Pitkin, San Miguel, Mineral, Summit, and Clear Creek counties, in the order named.

In Montana the production of lead increased from 3,216 tons in 1911 to 3,723 tons in 1912. Nearly all the metal-mining counties in Montana made a small yield of lead, but Cascade, Jefferson, Lincoln, and Silver Bow counties, with a production of 3,128 tons in 1912, against 2,392 tons in 1911, produced 84 per cent of the output for the State.

Idaho, with 142,093 tons, as against 136,278 tons, made a gain of 4 per cent in lead production in 1912 over that of 1911, which was the largest for several years. This output of lead was made by the mines of the Coeur d'Alene region and by two mines in Lemhi County. The lead smelter at Hahn was burned in September, and the only smelter operated in the State in 1912 was the old lead stack at Clayton, in Custer County, acquired by the Idaho Smelting & Mining Co. in the latter part of the year.

The production of lead in Utah in 1912 was 70,156 tons against 68,248 tons in 1911. Of the 1912 output, 31 per cent was derived from mines in the Bingham district, which produced 21,911 tons. The Park City district produced 21,056 tons in 1912, or 30 per cent of the total lead output, while the Tintic district mines yielded 11,786 tons.

The output of lead in Arizona in 1912 was 3,403 tons, as compared with 5,137 tons in 1911, a falling off of over 30 per cent, though it was still considerably above the average for the last few years. The ore came from the Warren district, of Cochise County, and from Mohave County.

Nevada produced six times as much lead in 1912 as in 1911, surpassing any production in the last ten years. The exact figures are 9,750 tons, as compared with 1,632 tons in 1911. The increase was due principally to adjustments of litigation and to the completion of the railroad spurs to Bullionville and at Pioche, Lincoln County, in 1912. Regular shipments of lead ore were made through the latter half of the year. Clark County also had a large lead output.

The production of lead in California in 1912, which was less than in 1911, was derived from Inyo, Mono, and San Bernardino counties. The exact quantities are 572 tons in 1912, as against 699 tons in 1911.

The output of lead in Washington in 1912 was only a little over one-sixth that of the previous year, there being only a few shipments from Stevens County. The total output was 64 tons. The Tacoma smelter was remodeled to treat copper ores.

METALLURGY.

CONCENTRATION AND SEPARATION.

The problems of concentration and separation of lead ores do not differ essentially from those concerning zinc ores or the complex sulphide ores of lead and zinc. The various adaptations of the principles of flotation and of electrostatic separation to such ores have been discussed in the chapters on zinc in Mineral Resources of the United States for 1908 and for 1910–1912, to which the reader is referred.

SMELTING.

LEAD SMELTERS AND REFINERIES IN 1912.

In the following list the attempt has been made to give all the lead smelters and refineries in existence or under construction in the United States in 1912. The plants which produced in 1912 are given in ordinary type; those which were idle are listed in italics.

List of lead smelters and refineries in the United States in 1912.

ARIZONA:
Mowry—*Consolidated Mines, Smelter & Transportation Co.*[1]
CALIFORNIA:
Keeler—*Four Metals Mining & Smelting Co.*[1]
Needles—Needles Mining & Smelting Co.[2]
Selby—Selby Smelting & Lead Co.[3] Refinery also.
COLORADO:
Denver—Globe plant, American Smelting & Refining Co.
Durango—Durango plant, American Smelting & Refining Co.
Georgetown—Western Metals Co. (Malm dry chlorination process.) Under construction.
Leadville—Arkansas Valley plant, American Smelting & Refining Co.
Pueblo—Pueblo plant, American Smelting & Refining Co.
Salida—The Ohio & Colorado Smelting & Refining Co.
IDAHO:
Clayton—Idaho Smelting & Mining Co.
Enaville—*North Fork Smelting & Mining Co.*
Ponderay—*Idaho Smelting & Refining Co.*[1]
Sea Foam—*Greyhound Mining & Milling Co.*[1]
ILLINOIS:
Aurora—Aurora Metal Co.[4]
Chicago—Goldsmith Bros.' Smelting & Refining Co.[4]
Chicago—National plant, American Smelting & Refining Co. Refinery only.
Collinsville—St. Louis Smelting & Refining Co.[5] Refinery also.
Federal—Federal Lead Co.[3]
Granite City—Hoyt Metal Co.[4]
INDIANA:
East Chicago—International Lead Refining Co.[6] Refinery only.
Grasselli—United States Metals Refining Co.[2] Refinery only. Betts electrolytic process.

[1] Not operated for several years.
[2] Subsidiary of United States Smelting, Refining & Mining Co.
[3] Subsidiary of American Smelters Securities Co.
[4] Smelters of secondary materials, but treating some lead ores.
[5] Subsidiary of National Lead Co.
[6] Subsidiary of International Smelting & Refining Co.

IOWA:
Dubuque—*J. W. Watters.*[1]
KANSAS:
Galena—Galena Smelting & Manufacturing Co.
MISSOURI:
Desloge—Desloge Consolidated Lead Co.
Granby—Granby Mining & Smelting Co.
Herculaneum—St. Joseph Lead Co.
Joplin—Picher Lead Co.
Valle Mines—*Valle Mining Co.*[1]
Webb City—Webb City Smelting & Manufacturing Co.
MONTANA:
Cooke—*New World Smelter & Mining Co.*
East Helena—East Helena plant, American Smelting & Refining Co.
NEBRASKA:
Omaha—Omaha & Grant Smelting Co.[2] Refinery only. Betts electrolytic process.
NEVADA:
Nelson—*Santa Barbara Searchlight Mining Co.*[1]
Spruce—*Black Forest Mines & Smelter Co.*[1]
NEW JERSEY:
Newark—Balbach Smelting & Refining Co. Refinery also.
Perth Amboy—Perth Amboy plant, American Smelting & Refining Co. Refinery also.
NEW MEXICO:
Deming—*National Mining & Smelting Co.*[1]
PENNSYLVANIA:
Carnegie—Pennsylvania Smelting Co.
TEXAS:
El Paso—Kansas City Consolidated Smelting & Refining Co.[2]
UTAH:
Midvale—United States Smelting Co.[3]
Murray—Murray plant, American Smelting & Refining Co.
Silver City—*Tintic Smelting Co.*
Tooele—International Smelting & Refining Co.
WASHINGTON:
Keller—*Keller & Indiana Consolidated Smelting Co.*[1]
Tacoma—Tacoma Smelting Co.[4]
WISCONSIN:
Dodgeville—*Blue Mounds Mining & Smelting Co.*[1]
Waukesha—*Northern Smelting Co.*[1]

NEW SMELTERS AND ADDITIONS TO CAPACITY.

The International Smelting & Refining Co. added a lead-smelting department to the copper smelter at Tooele, Utah. Two furnaces of 250 tons capacity each were completed in 1912, and two more were started before the close of the year. Early in 1913 a fifth furnace was begun. The roasting equipment consists of Dwight & Lloyd sintering machines, and there are adequate bag houses. An economical method of treating the leady copper matte from the lead furnaces has been developed at this plant. The hot matte, directly as drawn, is blown up in the copper converters, a portion of the lead being saved as fume in the bag houses, and another portion being caught in the converter slag, which is rich enough in lead to be recharged into the lead blast furnaces. At other refineries, notably at Omaha and Perth Amboy, the leady copper matte from distant plants must first be molten before being blown up in the converters.

[1] Not operated for several years.
[2] Subsidiary of American Smelting & Refining Co.
[3] Subsidiary of United States Smelting, Refining & Mining Co.
[4] Subsidiary of American Smelters Securities Co.

A subsidiary of the International Smelting & Refining Co., the International Lead Refining Co., completed a refining plant of 200 tons' capacity at East Chicago, Ind. The Parkes process of desilverization is employed.

The Balbach Smelting & Refining Co. removed its lead refinery from the former location to a site on Newark Bay and doubled its equipment and capacity.

The North American Smelting Co. completed a small lead smelter at Kingston, Ontario, Canada, and started operations at the close of the year. The plant is designed to treat the output of the lead mine belonging to the company near Kingston, and to do custom work for other small mines in that vicinity.

The smelter-fume problem continued to invite attack. A description of various plans proposed to overcome the objectionable fumes was given in the lead report for 1910. Where there is a market for sulphuric acid the sulphur gases may be converted into acid. The gases from Dwight & Lloyd machines sintering lead concentrates are being used in Germany for the manufacture of sulphuric acid. By selecting gases from a certain section of the draft intake area a gas much richer in SO_2 is obtained, and a small amount of gas poor in SO_2 is rejected.

But with a single western smelter discharging daily more than 500 tons of sulphur as SO_2,[1] it is clear that all the sulphur gases can not be profitably converted into sulphuric acid. The plans of simple neutralization of fume, although successful and at the present stage necessary, are nevertheless kept up at a dead expense and fall short of the goal of recovering a commercial by-product. One of the later methods to solve the problem is the Thiogen process of Prof. S. W. Young, which proposes to recover sulphur as a by-product. An experimental plan for trying out the process has been installed at the copper smelter of the Penn Mining Co., at Camp Seco, Cal., to handle the gases from the McDougall roasters. The object of the process is to reduce the sulphur gases to sulphur by means of a spray of crude oil. The hot sulphur gases are drawn into a flue heated to low red heat, where they are sprayed with crude oil, pass thence through a number of porous partitions in which the gases are brought into contact with the hydrocarbon and are thus reduced. From the flue the gases and sulphur pass into a condensing chamber, where they are sprayed with water and the sulphur is condensed. The remaining gases are drawn through a short flue to a stack.

The Hall sulphur process is another of the methods under development which aim to solve the smelter-fume problem. This process consists in roasting the sulphide ore in such a way that while the metallic bases are oxidized the sulphur is not, escaping with the fume as the sublimate. The sulphides are treated in a mechanical roaster of the McDougall type, in an atmosphere of reducing gases and steam, at a temperature between 600° and 900° C. The sulphur is collected in gas scrubbers, or may be condensed by the Cottrell system of electric precipitation. While applicable only to roasting furnaces in its present stage of development, it is hoped that this process may

[1] Carpenter, F. R., Smelter fumes, their condensation and utilization. Proc. Colorado Sci. Soc., vol. 9, 1908, p. 65.

be adapted to the treatment of blast-furnace gases. The market for sulphur, however, like that for sulphuric acid, as pointed out above, is restricted, so that any process of recovering pure sulphur from smelter fumes, if generally adopted, will necessarily be operated at dead expense.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The following table of the production of lead in the world has been calculated from the statistics published by the Metallgesellschaft, of Frankfurt-am-Main, Germany, with the exception of the substitution of the figures collected by the United States Geological Survey for the production of the United States. It is to be noted that the production of Africa and South America is not separately given in the table. As shown on a preceding page, considerable lead has been smelted and refined in the United States in the last six years from ores produced in those countries:

The world's production of lead, 1905–1912, in short tons.

Country.	1905	1906	1907	1908	1909	1910	1911	1912
Australia	117,946	102,514	106,923	131,174	85,098	108,907	109,789	118,387
Austria-Hungary	14,881	18,078	16,975	16,094	15,432	19,290	21,605	23,589
Belgium	25,243	24,471	28,417	39,352	44,423	44,864	48,832	62,941
Canada	28,329	26,235	13,338	18,849	22,928	16,535	11,795	17,968
France	26,565	28,219	25,353	28,770	29,652	22,266	26,014	36,376
Germany	168,211	166,117	157,156	180,887	185,076	176,258	177,801	181,880
Great Britain	25,684	26,455	30,203	32,738	31,085	32,628	28,660	31,967
Greece	15,102	13,338	15,212	17,637	16,865	18,519	15,763	15,983
Italy	21,054	23,479	25,243	28,660	24,361	15,983	18,408	22,597
Japan	2,535	3,858	3,858	3,197	3,748	3,858	4,630	4,960
Mexico	82,673	59,524	79,366	121,253	130,071	133,048	137,347	132,276
Russia	331	331	110	110	882	1,323	1,102	1,102
Spain	199,186	199,406	204,848	202,052	202,823	211,531	193,013	205,799
Sweden	661	882	882	331	220	441	1,213	1,433
Turkey in Asia	11,464	10,582	11,464	13,007	13,338	13,999	13,668	13,779
Other countries	220	220	220	551	6,393	17,306	22,597	13,448
United States (domestic, refined)	318,509	336,200	352,381	311,666	352,839	375,402	391,995	392,517
Total	1,058,594	1,039,909	1,071,949	1,146,328	1,165,234	1,212,158	1,224,232	1,277,002
United States percentage of world's production	30.1	32.3	32.9	27.2	30.3	31.0	32.0	30.7

The world's production of lead in 1912 showed a gain of 52,770 short tons, or 4.3 per cent, more than the production of 1911. The largest individual increase was in the production of Belgium, with a gain of 14,109 tons, or 28.9 per cent. Spain had an increase of 12,786 tons, but the production did not equal the record output for 1910. France was third, with an increase of 10,362 tons, or 39.8 per cent over the 1911 figures. Australia, Canada, Germany, Great Britain, and Italy each showed a good increase, and other countries contributed smaller gains. Mexico alone showed a decrease, the production for 1912 being 5,071 tons less than in 1911. This was doubtless due to the civil conflict in progress in that country.

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the lead goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the lead may be withdrawn for consumption by payment of duty, or it may remain in bond for smelting and refining, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The lead entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption which are expressed in the same terms as those in which they were imported. The lead imported for consumption may be actually used in this country, or it may be manufactured into articles which are exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign lead given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse.

The two items, foreign lead exported from warehouse and foreign lead exported in manufactures with benefit of drawback, make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity this foreign lead is carried on the bonded customs warehouse records in the form in which the lead was entered until the bond is canceled. It must be clearly understood, therefore, that in the table of foreign exports of lead, on a later page, the lead there listed was not exported as lead content of ore and base bullion but as refined lead smelted and refined from them. There is no record kept of the lead in the form in which it is actually exported except for a portion of the articles manufactured from foreign lead and exported with benefit of drawback. For articles not made wholly of lead it would be useless to give weights. But each shipment on which drawback is claimed is accompanied by a manifest of the imported lead used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign lead used in manufactures exported with the benefit of drawback. For this reason the lead is given in the form in which it was imported.

The following table, taken from the reports of the Bureau of Foreign and Domestic Commerce, shows the lead remaining in warehouse at the close of each year, beginning with 1899, and also the district in which remaining. For the reasons given above, the lead is shown in the terms in which imported. For instance, a considerable part of the lead stated as remaining in ore and base bullion doubtless represents refined lead waiting at the bonded refinery for

a favorable market for shipment. If this be borne in mind, the table gives a fair idea of the fluctuations of foreign stock at different times and in different localities.

Lead remaining in warehouse, 1899–1912, in pounds.

Dec. 31—	Form in which entered for warehouse.		Remaining at [a]—					
	Lead in ore and base bullion.	Pigs, bars, and old.	Newark, N. J.	Perth Amboy, N. J.	Chicago, Ill.	El Paso, Tex.	San Francisco, Cal.	Puget Sound.
1899	22,302,286	17,033	6,343,323	12,070,835	215,032	2,552,911	122,851	976,012
1900	42,379,270	.....	10,692,307	10,157,018	2,236,555	2,642,568	3,149,975	6,147,500
1901	33,225,677	18,808	5,927,039	7,964,931	.....	1,325,874	2,521,095	6,122,420
1902	47,817,806	59,487	8,198,289	14,176,702	4,157,558	2,949,481	3,745,809	2,073,152
1903	21,387,901	.....	5,192,823	3,850,638	3,896,471	4,079,021	3,430,526	938,422
1904	22,962,984	.....	1,629,852	7,482,560	5,999,972	6,062,072	1,732,742	46,295
1905	16,296,391	112	10,117	6,746,035	3,755,890	4,553,951	260,777	941,623
1906	11,382,998	128,812	1,743,853	3,870,951	2,736,979	229,267	306,607	2,480,817
1907	25,794,409	93,286	1,057,836	6,197,503	7,918,991	8,846,533	1,226,261	.....
1908	36,923,604	206,651	6,772,049	23,356,695	3,950,517	2,381,867	15,526	.....
1909	34,655,780	158,208	4,941,828	18,213,808	9,461,123	1,832,867	39,911	.....
1910	71,794,443	149,082	7,548,936	36,112,136	21,090,631	6,937,667	.....	.....
1911	8,869,713	93,082	2,777,692	2,308,322	954,884	2,555,733	.....	.....
1912	20,891,182	93,802	1,880,828	17,666,768	484,671	767,533	.....	.....

[a] Also in 1900 at Kansas City, Mo., 1,776,137 pounds, and at Omaha, Nebr., 5,306,351 pounds; in 1901 at Denver, Colo., 9,364,318 pounds; in 1902, at Denver, Colo., 12,516,815 pounds; in 1911 at Kansas City, Mo., 273,082 pounds; and in 1912 at Kansas City, Mo., 91,382 pounds.

IMPORTS.

The following tables of lead and type metal imported and entered for consumption and of general imports of lead are taken from the reports and records of the Bureau of Foreign and Domestic Commerce:

Lead imported and entered for consumption in the United States, 1900–1912, in pounds.

Year.	Lead in ore.[a]		Base bullion.[b]		Pigs, bars, and old.		Sheets, pipe, and shot.		Not otherwise specified.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1900	10,209,742	$623,802	.....	.....	3,673,616	$76,141	27,945	$1,393	$877	$702,213
1901	10,324,119	272,396	.....	.....	3,604,157	88,056	56,735	2,773	1,234	364,459
1902	14,499,339	316,005	.....	.....	12,443,615	319,035	224,209	7,765	5,258	648,063
1903	41,155,130	716,128	.....	.....	8,972,635	255,135	17,008	810	1,589	973,662
1904	19,015,540	328,279	.....	.....	17,334,033	480,823	69,581	2,441	5,277	816,820
1905	49,526,990	784,548	.....	.....	10,379,753	329,209	77,668	3,813	1,139	1,118,709
1906	44,560,258	755,545	587,731	$15,635	24,882,983	960,998	346,177	17,250	4,503	1,753,931
1907	13,363,875	286,802	1,196,224	35,303	15,667,170	718,198	734,418	39,210	3,450	1,082,944
1908	2,806,524	76,746	11,415,463	251,266	5,346,290	176,363	42,377	2,026	9,843	516,244
1909	7,080,753	142,847	21,896,611	454,568	7,095,442	229,751	40,434	2,056	32,284	861,506
1910	7,998,859	198,196	16,543,167	37,223	6,776,066	212,858	39,779	1,972	4,843	755,092
1911	1,474,254	26,563	17,376,459	352,595	7,112,749	242,423	63,151	2,855	7,218	631,654
1912	935,861	24,760	22,729,467	462,559	5,191,823	110,459	31,184	2,305	5,468	605,551

[a] For period 1900–1905, inclusive, the gross weight and value of base bullion imported for consumption are also included.

[b] For the years previous to 1906 the imports of base bullion (gross weight) are not distinguished from imports of lead in ore.

Type metal imported and entered for consumption, 1899–1912, in pounds.

Year.	Type metal.		Lead content.[a]	
	Gross weight.	Value.	Pounds.	Percentage.
1899	1,110,188	$56,442	.....	.....
1900	1,032,866	51,242	.....	.....
1901	3,222,431	116,875	.....	.....
1902	6,469,971	194,394	.....	.....
1903	6,603,863	208,728	.....	.....
1904	8,143,749	221,127	6,884,423	84.5
1905	13,932,013	456,155	11,476,629	82.4
1906	19,602,471	900,608	15,896,629	81.1
1907	14,832,673	932,027	12,095,027	81.5
1908	4,110,486	156,847	3,265,815	79.5
1909	13,993,889	532,108	11,339,378	81.0
1910	13,394,199	485,493	11,176,830	84.9
1911	8,390,470	310,658	6,936,711	82.7
1912	581,411	18,668	477,006	82.0
Average lead content, 1904–1912	.....	.....	.....	82.0

[a] Prior to 1904 the lead content of the type metal was not given. Besides lead, the chief constituent of the type metal is antimony.

Imports of lead, in ore, base bullion, and refined, by countries, 1906–1912, in pounds.

Country.	1906	1907	1908	1909	1910	1911	1912
United Kingdom	9,852,760	433,971	399,569	191,243	1,874,750	401,686	279,546
Germany	2,006,369	456,649	695,151	2,821,967	421,377	56,286	494,237
Other European countries	3,920,313	6,922,276	1,699,509	1,385,616	418,669	111,189	55,356
Total from Europe	15,779,442	7,812,896	2,794,229	4,398,826	2,714,796	569,161	829,139
British North America	18,514,244	13,272,900	1,291,044	4,133,755	206,979	270,947	319,497
Mexico	133,512,526	137,543,692	219,567,193	215,203,714	203,290,307	172,633,479	159,455,664
South America	315,265	883,355	469,770	1,942,847	6,598,263	4,778,221	3,207,936
Other countries	147,462	117,138	26,418	2,683,950	4,394,421	1,651,544	3,309,356
Total imports	168,268,939	159,629,981	224,148,654	228,363,092	217,204,766	179,903,352	167,121,592

In the foregoing table the lead imports in 1912 from Europe consisted about one-half of lead in ore. Of the lead imported from Mexico, 12,344,064 pounds was in ore, 146,999,168 pounds was contained in the base bullion, constituting the whole imports of base bullion into the United States, and 112,457 pounds was in the form of refined lead. From Chile there was imported 3,206,256 pounds of lead in lead ore and from German East Africa 3,182,287 pounds in lead ore.

The table following shows the imports of lead in ore, base bullion, and pigs, bars, sheets, and old for the years 1907–1912.

Imports of lead, by classes, 1907–1912, in pounds.

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total lead content.[a]
		Gross weight.	Lead content.[a]		
1907	64,815,254	76,259,828	74,594,313	18,554,899	157,964,466
1908	64,708,204	153,921,829	150,560,176	5,518,621	220,787,001
1909	71,357,868	149,852,559	146,579,779	7,152,665	225,090,312
1910	94,751,054	118,061,415	115,483,542	6,970,170	217,204,766
1911	35,686,180	141,481,852	138,952,372	5,264,800	179,903,352
1912	19,577,499	152,420,624	146,999,168	544,925	167,121,592

[a] Lead content of bullion for 1907–1909 estimated on the basis of average lead content of imports of base bullion in 1910.

EXPORTS.

DOMESTIC EXPORTS.

The average difference between the New York and the London lead prices for the last 10 years has been not far from 1½ cents per pound. This being the case, domestic lead exports should be expected only under temporary and very unusual circumstances. The practice of the Bureau of Foreign and Domestic Commerce is to class all exports of lead articles manufactured in this country as domestic exports, whether the lead be of domestic or foreign origin. The table of exported lead and manufactures of lead of domestic production, made up from the records of the Bureau of Foreign and Domestic Commerce, and heretofore published in this report, must be duplicated in part, if not completely, in the following table of exports of manufactures with benefit of drawback. For this reason it has been decided to abandon the table of domestic exports as previously published.

FOREIGN EXPORTS.

By foreign lead exports is meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total lead exported for a period of years; but it must be borne in mind, as pointed out on a previous page, that the actual exports were not in the form shown in the table, which is the import form, but instead consisted of refined lead and lead manufactures. The quantities of lead exported are exact, but the quantities given of lead in manufactures are subject to the waste in manufacturing.

Under the present tariff regulation, as also under the tariff of 1909, the lead that must be sent out before the bond can be canceled is that actually recovered in smelting and refining the ore and base bullion. Under the tariff of 1897 the bond was canceled when 90 per cent of the lead content of the ore or gross weight of the base bullion was shipped out. If, then, in refining base bullion more than 90 per cent of the total weight was recovered as lead, the bond would be canceled on the exportation of that 90 per cent and the excess above 90 per cent could remain in this country without payment of duty. No doubt prior to 1909 considerable foreign lead used in this country has escaped duty in this wise.

Exports of foreign lead, 1900–1912, in pounds.

Year.	Exported from warehouse.							Exported in manufactures with benefit of drawback.	
	Lead content ore.[a]		Lead content base bullion.[a]		Pigs, bars, and old.		All other manufactures.	Lead content ore.	Pigs, bars, bullion, and old.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	Quantity.	Quantity.
1900..	197,795,960	$3,840,798	.....	.....	30,163	$564	$2,519	1,705,970	6,861,030
1901..	194,724,197	4,183,101	.....	.....	50,000	2,500	4,924	9,452,628	5,935,331
1902..	157,891,135	3,551,380	.....	.....	43,130	1,000	764	2,173,559	9,501,049
1903..	163,774,605	2,908,531	.....	.....	55,566	1,627	7,799	2,339,106	9,331,256
1904..	167,686,199	2,844,403	.....	.....	87,471	3,937	32,467	2,946,810	10,445,974
1905..	117,263,861	2,378,327	.....	.....	1,647,523	54,993	7,846	3,584,610	12,700,971
1906..	94,449,751	2,303,382	.....	.....	48,680	1,138	2,825	3,447,478	8,536,424
1907..	102,847,310	2,416,082	.....	.....	47,078	2,169	3,033	1,826,756	14,709,149
1908..	153,657,371	3,068,427	.....	.....	56,000	1,500	32,026	9,392,428	9,114,209
1909..	118,325,560	2,002,644	[b] 53,817,393	$1,036,080	11,447	487	697	2,992,967	6,598,149
1910..	22,508,090	248,220	117,045,333	2,262,057	19,507	703	870	6,592,294	11,008,604
1911..	39,276,820	730,247	151,986,265	3,093,290	12,311,102	244,037	1,504	674,621	23,485,929
1912..	12,796,703	219,859	116,907,305	2,478,256	107,170	3,826	2,121	150,617	22,584,221

[a] Prior to June, 1909, exports of foreign lead from warehouse do not distinguish between lead content of ore and gross weight of base bullion.
[b] For six months, July–December, 1909.

CUSTOMS DUTIES.

The sections of the tariff act of 1909 which were concerned with lead and lead products are as follows:

181. Lead-bearing ore of all kinds, one and one-half cents per pound on the lead contained therein: *Provided*, That on all importations of lead-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

182. Lead dross, lead bullion or base bullion, lead in pigs and bars, lead in any form not specially provided for in this section, old refuse lead run into blocks and bars, and old scrap lead fit only to be remanufactured; all the foregoing, two and one-eighth cents per pound; lead in sheets, pipe, shot, glaziers' lead, and lead wire, two and three-eighths cents per pound.

191. Type metal, one and one-half cents per pound on the lead contained therein.

49. Red lead, two and five-eighths cents per pound.

53. White lead, and white pigment containing lead, dry or in pulp, or ground or mixed with oil, two and one-half cents per pound.

58. Lead: Acetate of, white, three cents per pound; brown, gray, or yellow, two cents per pound; nitrate of, two and one-fourth cents per pound; litharge, two and one-half cents per pound.

SEC. 24. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals may, upon the giving of satisfactory bonds, be

designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there smelted or refined, or both, together with other ores or crude metals of home or foreign production: *Provided*, That the several charges against such bonds may be canceled upon the exportation or delivery to a bonded manufacturing warehouse, established under section twenty-three of this act, of the actual amount of lead produced from the smelting or refining, or both, of such ores or crude metals: *And provided further*, That said lead may be withdrawn for domestic consumption or transferred to a bonded customs warehouse and withdrawn therefrom upon the payment of the duties chargeable against it in that condition: *Provided further*, That all labor performed and services rendered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

The Consolidated Kansas City Smelting & Refining Co. having protested the assessment of duty at El Paso upon both lead and zinc contents of an ore carrying more than 10 per cent of zinc, which zinc was alleged to be lost in smelting, the board of United States General Appraisers on June 27, 1910, affirmed (T. D. 30727) the imposition of duty upon both lead and zinc contents under the provisions of paragraphs 181 and 193 of the tariff of 1909. The plaintiff having carried the case to the United States Court of Customs Appeals, that body overruled the importers' claim (T. D. 31509) and sustained the action of the collector.

The American Smelting & Refining Co. protested the assessment of a duty of $2\frac{1}{8}$ cents per pound upon antimonial lead withdrawn from the bonded smelting warehouse at Perth Amboy. It was claimed that the by-product, antimonial lead, is of the composition of type metal, that it was withdrawn for use as type metal, and that it should be dutiable at the rate of type metal—that is, $1\frac{1}{2}$ cents per pound upon the lead contents thereof, as provided in paragraph 191 of the tariff of 1909. It was also urged that the same results could be secured by withdrawing the antimonial lead from bond for export and thereafter reimporting it as type metal. The United States Board of Appraisers (T. D. 31201) affirmed the assessment of duty and overruled the protest. The importers having appealed the case to the United States Court of Customs Appeals, that body, October 12, 1911, reversed the decision of the Board of Appraisers. During the course of the appeal it developed that antiminial lead has an average composition of 81 per cent of lead, 17 per cent of antimony, and 2 per cent of other metals, such as arsenic, copper, etc., and that since 1907 it has been regularly imported and entered for consumption as type metal. In this connection it may be remarked that a comparison of the table of production of antimonial lead showing the antimony content of that metal and the table of imports of type metal showing the lead content of that metal is in substantial agreement with the foregoing fact.

In response to a request for instructions from the collector of customs at El Paso regarding the proper classification of matte entered as copper matte, but containing from 4 to 18 per cent of lead, the Treasury Department ruled (T. D. 32439) that matte containing more than 10 per cent of lead is not properly a copper matte, entering duty free, but is dutiable under paragraph 181 of the tariff act of 1909 at $1\frac{1}{2}$ cents per pound on the lead contained.

The new tariff act of 1913 has the following paragraphs relating to lead and lead compounds:

152. Lead-bearing ores of all kinds containing more than 3 per centum of lead, ¾ cent per pound on the lead contained therein: *Provided*, That on all importations of lead-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

153. Lead dross, lead bullion or base bullion, lead in pigs and bars, lead in any form not specially provided for in this section, old refuse lead run into blocks and bars, and old scrap lead fit only to be remanufactured; lead in sheets, pipe, shot, glaziers' lead, and lead wire; all the foregoing, 25 per centum ad valorem, on the lead contained therein.

160. Type metal, and types, 15 per centum ad valorem.

56. Lead pigments: Litharge, orange mineral, red lead, white lead, and all pigments containing lead, dry or in pulp, and ground or mixed with oil or water, not specially provided for in this section, 25 per centum ad valorem.

57. Lead, acetate of, white, and nitrate of, 1¼ cents per pound; acetate of, brown, gray, or yellow, 1 cent per pound; all other lead compounds not specially provided for in this section, 20 per centum ad valorem.

The new tariff modifies section 24 of the tariff of 1909 by substituting the word "metal" where the word "lead" is used, so as to make smelting in bond apply to all other metals as well as to lead.

N. Subsection 1. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals, may upon the giving of satisfactory bonds be designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there smelted or refined, or both, together with ores or crude metals of home or foreign production: *Provided*, That the bonds shall be charged with the amount of duties payable upon such ores and crude metals at the time of their importation, and the several charges against such bonds may be canceled upon the exportation or delivery to a bonded manufacturing warehouse established under Paragraph M of this section of an amount of the same kind of metal equal to the actual amount of dutiable metal producible from the smelting or refining, or both, of such ores or crude metals as determined from time to time by the Secretary of the Treasury: *And provided further*, That the said metals so producible, or any portion thereof, may be withdrawn for domestic consumption, or transferred to a bonded customs warehouse, and withdrawn therefrom, and the several charges against the bonds canceled upon the payment of the duties chargeable against an equivalent amount of ores or crude metals from which said metal would be producible in their condition as imported: *And provided further*, That on the arrival of the ores and crude metals at such establishments they shall be sampled and assayed according to commercial methods under the supervision of Government officers, to be appointed by the Secretary of the Treasury and at the expense of the manufacturer: *Provided further*, That antimonial lead produced in said establishments may be withdrawn for consumption upon the payment of the duties chargeable against it as type metal under existing law and the charges against the bonds canceled in a similar sum: *Provided further*, That all labor performed and services ren-

dered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

Under the tariff of 1897 the customs bond was canceled upon the exportation of 90 per cent of the weight of base bullion or lead contents of ore imported. Under the tariff of 1909 the bond is canceled only upon the exportation of the actual quantity of lead produced from the base bullion and ore. This change made it compulsory upon the Treasury Department to ascertain the exact recovery and wastage of lead. Prof. H. O. Hofman, of the Massachusetts Institute of Technology, was employed to investigate the wastage in both smelting and refining at the various bonded smelters. His report, being confidential, has not been given out by the Treasury Department. The following, taken from the Engineering and Mining Journal of June 17, 1911, purports to give the general results of the investigation:

It appears that Prof. Hofman in his investigations at the various bonded smelting warehouses found that there was a wide divergence in the amount of waste at the various places owing to the different character of the ores. He, therefore, recommended the establishment of the actual wastage at each plant as determined from a scrutiny of the records for three years back. * * * Prof. Hofman's reports showed that the wastage in smelting varied from 5 or 6 per cent at some plants to over 20 at others. There was also a wide variation of the loss incurred in refining base bullion, the figure running as low as less than 1 per cent in some cases, while in others it was very greatly in excess of that. Probably the most refractory ores studied by Prof. Hofman were those which were smelted at Perth Amboy, N. J. These are the Canadian ores, and the difficulty with them is due to the presence of large quantities of arsenates. Some plants have stopped smelting these ores on account of the high percentage of waste connected with them.

From the same journal, under date of March 8, 1913, the following, relating to a later examination, is taken:

The Treasury Department has completed investigations as to works of the American Smelting & Refining Co. at Perth Amboy, N. J., and finds that there was a loss in the operation equal to 20 per cent to be accounted for as wasted. In lead bullion it was found from the records that there was a loss in refining operations equal to 3.7 per cent to be accounted for as wasted. Previous regulations were modified in conformity to these findings. As a result of recent experience it is now stated that the department will fix wastage allowances each year. Notification has been sent to the companies that they will have to prepare to make detailed statements of the facts, showing the losses on the metals worked during the fiscal year ending June 30 in each year. An allowance of 19.9 per cent in the smelting of imported lead-bearing ores has been granted in the case of El Paso Smelting & Refining Works at El Paso, Tex.

CONSUMPTION.

In statements of lead consumption in these reports prior to 1907 it was the custom to take into account the smelter stocks of lead at the beginning and at the close of the year. It is not to be denied that for the individual year this gives closer figures. It is just as true that account of trade stocks should also be taken to arrive at accurate results; but this is manifestly outside the scope of this bureau. It has been found impossible to obtain a statement of stocks from one large producer since 1906; hence consumption has been calculated without reference to domestic stocks. A very considerable part, however, amounting to between one-fourth and one-fifth of the

lead smelted and refined in this county, is lead of foreign origin smelted in bond, and it is possible to obtain the stocks of this portion, since they are reported annually by the Bureau of Foreign and Domestic Commerce as "merchandise remaining in warehouse at close of year." A certain element of error is introduced by the fact that the imports, the exports, and the warehouse stocks, as given, include lead in both ore and base bullion. So far as imports are concerned, the relative quantities of lead in ore and of base bullion are shown in the table on a preceding page, entitled "Imports of lead, by classes," based upon the records of the Bureau of Foreign and Domestic Commerce, and corroborated in the preceding table giving the "sources of primary lead smelted or refined in the United States," based upon smelter reports. For exports and warehouse stocks no such division can be made, because the classes used therein represent the condition of the metal when imported and do not change with the reduction of the metal in bond. Nevertheless, it is deemed advisable to use warehouse stocks as giving a better estimate of consumption. It is necessary, therefore, to include all classes of lead imports as well as all classes of lead exports.

In the following table "lead" includes all kinds—lead in ore, base bullion, pigs, bars, and old. The figures of domestic production are based upon the returns by the smelters; all other figures are from the records of the Bureau of Foreign and Domestic Commerce. Decrease by liquidation covers losses in smelting and refining in bond and other corrections. Because warehouse stocks are used in lieu of smelter stocks the result given below is lead "available for consumption." The "apparent consumption" of previous reports would be this quantity increased or diminished by the increase or decrease of domestic stocks during the year.

Primary lead available for consumption in the United States, 1907–1912, in short tons.

	1907	1908	1909	1910	1911	1912
Supply:						
Stock in bonded warehouses Jan. 1	5,756	12,944	18,565	17,405	35,972	4,481
Imports—						
For consumption	15,246	9,805	18,036	15,359	13,281	14,146
For warehouse	64,569	102,241	96,145	93,249	76,671	69,414
Production from domestic ores	352,381	311,666	352,839	375,402	391,995	392,517
Total supply	437,952	436,656	485,585	501,415	517,919	480,558
Withdrawn:						
Exports of foreign lead—						
From warehouse	51,447	76,857	86,077	69,786	101,227	64,906
In manufactures, with benefit of drawback	8,268	9,254	4,796	8,800	12,080	11,320
Decrease by liquidation	4,578	13,425	8,643	7,661	14,812	5,692
Stock in bonded warehouses Dec. 31	12,944	18,565	17,405	35,972	4,481	10,492
Total withdrawn	77,237	118,101	116,921	122,219	132,600	92,410
Available for consumption	360,715	318,555	368,664	379,196	385,319	388,148

For facility of comparison of consumption in the United States with that of the world, the consumption of the former has been calculated with and without stocks for a period of years, as shown in the following table. Consumption of lead, as shown in the second column, means the production of refined lead minus excess of exports over imports or plus excess of imports over exports. Additions made to stock during the year will thus appear as consumed, but as such stocks are apt to go into the market within the next year and cut down the apparent consumption to that extent, they must compensate in the long run, leaving an accurate average measure of the consumption. The statistics of consumption of foreign countries as given in the table are taken from the estimates of the Metallgesellschaft, etc., which are also compiled without regard to stocks. In the following table, the first column gives, for the sake of comparison, the consumption with stocks taken into consideration; the remainder of the table disregards stocks. In neither column showing the United States consumption is the production of secondary lead taken into account.

World's consumption of pig lead, exclusive of secondary lead, 1898–1912, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States, percentage.
1898	227,452	225,177	651,018	876,195	25.7
1899	226,315	230,294	652,782	883,076	26.1
1900	269,302	279,172	667,002	946,174	29.5
1901	271,934	284,126	663,805	947,931	29.9
1902	332,484	300,643	685,079	985,722	30.5
1903	300,167	284,556	701,945	986,501	28.8
1904	319,543	320,330	719,471	1,039,801	30.8
1905	347,015	343,682	736,998	1,080,680	31.8
1906	376,337	376,981	705,142	1,082,123	34.8
1907	[a] 360,715	367,903	708,229	1,076,132	34.2
1908	[a] 318,555	324,176	829,353	1,153,529	28.1
1909	[a] 368,664	367,504	815,038	1,182,542	31.1
1910	[a] 379,196	397,763	812,946	1,210,709	32.9
1911	[a] 385,319	353,828	873,573	1,227,401	28.8
1912	[a] 388,148	394,159	883,052	1,277,211	30.9

[a] See preceding table, "Primary lead available for consumption in the United States" in 1907–1912.

Consumption of lead, stocks and secondary lead disregarded, in 1906–1912, by countries, in short tons.

Country.	1906	1907	1908	1909	1910	1911	1912
Australia	4,960	5,952	8,501	5,401	7,037	10,031	11,133
Austria-Hungary	26,235	27,778	31,906	34,171	34,722	39,903	41,777
Belgium	26,786	34,723	28,880	48,060	35,274	59,083	55,997
Canada	17,416	15,653	15,102	23,589	19,621	23,259	33,069
France	94,688	89,397	114,749	112,765	98,986	109,789	117,395
Germany	214,838	206,130	233,275	235,010	231,924	253,309	243,057
Great Britain	213,956	214,287	252,595	223,436	229,719	218,586	216,161
Holland	5,512	5,732	5,961	6,504	7,165	7,496	6,944
Italy	33,400	33,290	40,296	34,612	31,085	40,013	35,274
Japan	15,983	15,983	10,582	12,676	18,188	20,833	27,006
Russia	27,558	27,668	49,349	42,328	53,792	47,509	50,265
Switzerland	5,842	5,842	6,514	5,842	6,504	5,512	7,055
Other European countries	3,307	3,417	4,416	4,409	4,740	3,858	4,850
Other countries	14,661	22,377	27,227	26,235	33,289	34,392	33,069
United States	376,981	367,903	324,176	367,504	397,763	353,828	394,159
Total	1,082,123	1,076,132	1,153,529	1,182,542	1,210,709	1,227,401	1,277,211

USE OF LEAD IN THE UNITED STATES.

The United States Geological Survey does not collect statistics of the use of lead. The following table is from figures published in the Engineering and Mining Journal, which purport to cover about 90 per cent of the total consumption. The figures for 1910 to 1912 are not available, but a fair idea may be gained from the years for which there are figures.

Use of lead in the United States, 1907–1909.

	1907		1908		1909	
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.
	Short tons.		*Short tons.*		*Short tons.*	
White lead and oxides	115,000	34.8	117,500	40.5	134,138	38.0
Pipe	41,000	12.4	33,800	11.6	52,914	15.2
Sheets	21,500	6.5	16,400	5.7	23,421	6.7
Shot	28,000	8.5	31,600	10.9	36,433	10.4
Other purposes	125,238	37.8	90,700	31.3	104,094	29.7
Total	330,738	100.0	290,000	100.0	351,000	100.0

PRICES AND VALUE.

PRICES.

Lead began the year at New York with a price of 4.475 cents a pound and held this figure through January. A sharp decline brought the lowest price of the year by the middle of February, with lead at 4.05 cents a pound. A long rise, with one considerable depression in August, brought the price to 5.1 cents by the middle of September. Here the price remained practically stationary until the close of October, after which a sharp decline carried the price down to 4.35 cents, at about which it closed the year. The average New York price for the year was again 4.5 cents a pound, as it was in 1911. These are the figures used in calculating the value of the lead production of the United States for those years.

The London price of lead started at £15 12s. 6d. a long ton (3.375 cents a pound) and rose very little above that figure for the first five months, after which a steady rise culminated early in September in a price of £23 a long ton (4.97 cents a pound), the highest price reached in over 30 years. At this time the New York price of lead was 5.1 cents a pound. A sharp decline through two months was followed by stationary prices, the year closing with lead at about £18 2s. 6d. a ton (3.92 cents a pound). The average London price of lead for 1912 was £17 18s. 10d. a long ton (3.88 cents a pound).

In the following table are shown the highest and the lowest prices of lead at New York in each month during the last 12 years. All figures for prices are in cents per pound. Those for 1906 and later are based upon daily quotations published in the Engineering and Mining Journal and those for preceding years on quotations published in the Iron Age.

Highest and lowest prices of lead at New York City, monthly, 1901–1912, in cents per pound.

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.00	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.10	4.05	4.10	4.05	4.65	4.10	4.65	4.35
1904	4.50	4.45	4.50	4.40	4.60	4.50	4.60	4.50
1905	4.60	4.45	4.50	4.45	4.50	4.45	4.55	4.50
1906	5.60	5.60	5.60	5.35	5.35	5.35	5.50	5.35
1907	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1908	3.80	3.55	3.75	3.70	4.00	3.65	4.10	3.90
1909	4.22½	4.12½	4.15	3.92½	4.10	3.92½	4.25	4.10
1910	4.70	4.70	4.70	4.52½	4.60	4.35	4.40	4.35
1911	4.52½	4.50	4.50	4.50	4.50	4.45	4.50	4.47½
1912	4.50	4.25	4.30	4.05	4.25	4.05	4.30	4.17½

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.35	4.30	4.35	4.10	4.10	4.05	4.10	4.05
1904	4.50	4.25	4.35	4.20	4.30	4.10	4.20	4.10
1905	4.55	4.50	4.55	4.50	4.60	4.50	4.85	4.60
1906	5.75	5.50	5.75	5.75	5.75	5.75	5.75	5.75
1907	6.00	6.00	6.00	5.75	5.75	5.25	5.25	5.25
1908	4.37½	4.05	4.52½	4.32½	4.52½	4.40	4.62½	4.47½
1909	4.35	4.20	4.35	4.35	4.35	4.30	4.42½	4.27½
1910	4.37½	4.25	4.40	4.30	4.45	4.35	4.40	4.40
1911	4.47½	4.45	4.50	4.45	4.60	4.50	4.60	4.55
1912	4.20	4.15	4.50	4.20	4.75	4.50	4.85	4.47½

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.00
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.40	4.10	4.40	4.35	4.40	4.19	4.25	4.10
1904	4.25	4.20	4.30	4.20	4.50	4.20	4.65	4.60
1905	4.90	4.85	5.30	4.85	5.40	5.15	5.90	5.25
1906	5.75	5.75	5.75	5.75	5.75	5.75	6.00	5.75
1907	5.25	4.75	4.75	4.75	4.75	4.00	4.10	3.35
1908	4.60	4.52½	4.47½	4.20	4.40	4.25	4.30	4.12½
1909	4.40	4.32½	4.37½	4.32½	4.40	4.32½	4.70	4.37½
1910	4.40	4.40	4.40	4.40	4.50	4.40	4.50	4.50
1911	4.55	4.50	4.50	4.25	4.50	4.25	4.47½	4.47½
1912	5.12½	4.80	5.15	5.00	5.00	4.50	4.50	4.32½

PRICE CURVES.

The fluctuations in the price of lead at New York and London are graphically shown in figure 5, which gives curves of the weekly average price of lead in those markets for the years 1911 and 1912. The independence of the New York market, except beyond the limit set by the tariff differential, is manifest, as is also the striking artificiality of that market.

VALUE.

The production of primary lead from domestic ores in 1912 was 415,395 short tons, valued at $37,385,550, based on the average New York price, as compared with 405,863 short tons, valued at $36,527,670, based on the average New York price in 1911, a gain of

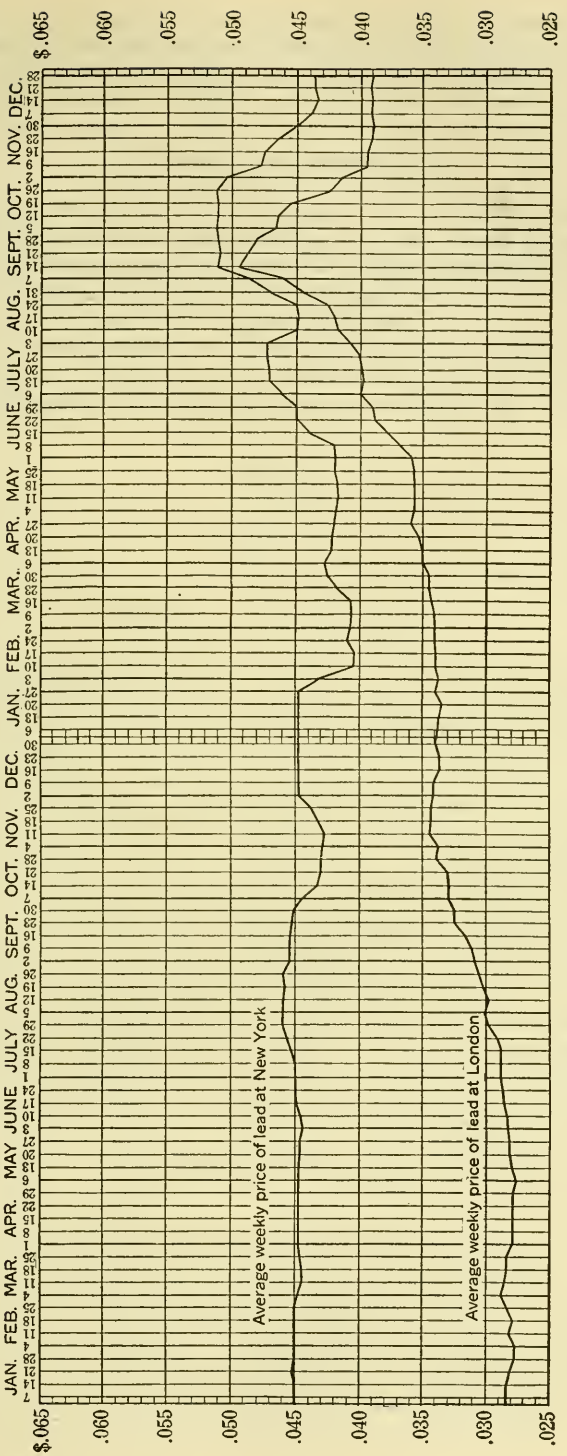

FIGURE 5.—Average weekly price of lead at New York and London, 1911–12.

9,532 tons, equal to 2.35 per cent in quantity, and of $857,880, equal to 2.35 per cent in value. In 1910 the production was 389,211 tons, valued at $34,250,568; in 1909 it was 363,319 short tons, valued at $31,245,434; and in 1908 it was 310,762 short tons, valued at $26,104,008.

CANADIAN LEAD BOUNTY.

The bounty paid by the Dominion of Canada to lead producers amounts to 75 cents per 100 pounds lead content of Canadian ore delivered to Canadian smelters when the London price of lead does not exceed £14 10s. per long ton (3.15 cents per pound). With increase in the price of lead the bounty decreases at the same ratio, ceasing altogether when lead is about £18 per long ton (3.91 cents per pound). The result of the bounty is to maintain to the producers a steady value for lead, under the present arrangement, of £18 per long ton.

Upon the termination of the first period of five years of operation of the bounty on June 30, 1908, it was renewed for a second period of five years, with the maximum and minimum London price limits each raised £2 per long ton, giving the figures cited above. The lead production of Canada is chiefly from the mines of British Columbia. Prior to the enactment of the bounty this lead was largely smelted and refined in the United States, but since that time the ore has been smelted in Canada.

The following figures, showing the amounts paid during several periods to March 31, 1912, are taken from the reports of the Canada department of mines:

Statement of bounties paid on lead during the fiscal years 1899 to 1912.

Year ending June 30—	Bounty paid.	Year ending Mar. 31—	Bounty paid.
1899	$76,665	1907 (9 months)	$1,995
1900	43,335	1908	51,001
1901	30,000	1909	307,433
1902		1910	340,542
1903	4,380	1911	248,534
1904	195,627	1912	179,288
1905	330,645		
1906	90,196	Total	1,899,641

THE LEAD CONVENTION.

The lead convention, formed at Paris early in 1909, and known as the International Sales Association, became effective May 1 of that year. It is composed of Spanish, Belgian, and German producers and metal-selling companies, together with Australian and American producers who consign lead to the European markets. The principal German producer, the Braubach silver-lead works, though not a member of the association, is acting in concert. The object of the association is to eliminate price cutting and sharp fluctuations and, by the establisment of a common selling agency and the allotment of spheres of sales, to introduce economies in the sale and delivery of lead. The Metallgesellschaft is the selling agency and Frankfort on the Main the chief market for metal controlled by the association, which is said to be about half the European supply.

At the close of the first year of the convention there were rumors of dissatisfaction among the members, and many predictions were made that the association would not be renewed. However, after a period of uncertainty which forced lead down to the lowest price of the year, the convention, in May, 1910, was established for another year, and it has been continued since. The association has had to meet the active competition of the independent producers and of the large metal houses.

That prices have been more stable and less subject to sudden fluctuations since the organization of the convention is evident. Though the first two years of the convention were not marked by any advance in prices, the first half of the third year of its operation, as may be seen by an inspection of figure 5, has shown a gradual rise in the price of lead, carrying the metal to the highest point reached since the panic of 1907, while at the same time the price in the United States has remained nearly stationary, or even lost a little.

It was reported that early in 1912 the International White Lead Convention was formed at London by British, continental, and American makers of white lead. Coincident with the formation of the association, there was an advance in the London price of white lead from £16 to £22 a ton, with white lead ground in oil advanced in proportion.

SUMMARY.

The following tabular statement gives the general items regarding domestic and world production and consumption of lead. The figures for domestic items are those compiled by this office, and the figures for the world items are based upon statistics compiled by the Metallgesellschaft.

Summary of lead statistics, 1907–1912, in short tons.

	1907	1908	1909	1910	1911	1912
Total production of refined lead in the United States	413,389	396,564	446,901	470,272	486,979	480,894
Production of desilverized lead in the United States	313,588	295,552	329,751	328,954	331,032	339,646
Production of soft lead in the United States (including desilverized soft)	129,630	130,881	149,690	169,270	191,614	171,037
Production of antimonial lead in the United States	9,910	13,629	12,896	14,069	14,078	13,552
Production of lead from domestic ores	352,381	311,666	352,839	375,402	391,995	392,517
Production of secondary lead in the United States	25,661	18,401	41,687	55,422	54,284	67,168
Consumption of lead in the United States (disregarding stocks)	367,903	324,176	367,504	397,763	353,828	394,159
World production (approximate)	1,071,949	1,146,328	1,165,234	1,212,158	1,224,232	1,277,002
World consumption (approximate)	1,076,132	1,153,529	1,182,542	1,210,709	1,227,401	1,277,211
United States (domestic) percentage of world production	32.9	27.2	30.3	31.0	32.0	30.7
United States percentage of world consumption	34.2	28.1	31.1	32.9	28.8	30.9
World rank of United States in production of lead	First.	First.	First.	First.	First.	First.
World rank of United States in consumption of lead	First.	First.	First.	First.	First.	First.

BIBLIOGRAPHY.

A list of the more important publications on lead and zinc published by the United States Geological Survey is given in the chapter on zinc in Mineral Resources for 1912.

ZINC.

By C. E. Siebenthal.

INTRODUCTION.

An estimate of the production of primary[1] spelter in 1912 was given out in the form of a press bulletin on January 2, 1913. This was based on reports from every smelter and gave the actual production for the first 11 months with an estimate for the remainder of the year. The total thus obtained was about one-twentieth of 1 per cent less than the final figures which were given in the advance statement of spelter production and consumption published February 15, 1913. This very close agreement indicates the great care used by the smelters in making up their New Year estimates for the Survey and shows that, so far as the general production is concerned, the Survey's New Year figures, for all practical purposes, may be accepted as final.

In July, 1911, a mid-year census was taken of the production of spelter during the first six months of the year, and the results were given out in the form of a press bulletin. This plan has since been followed and has been so well approved by producers and others that it will hereafter be a feature of the Survey's zinc reports, as it was formerly, from 1892 to 1901, inclusive. The production by semiannual periods from 1911–1913 is given on a later page.

The present report includes the figures given out in the advance statement and contains in addition tables of imports and exports of spelter and of zinc ore, a comparison of mine and smelter returns, a list of zinc smelters, a brief review of the advance in metallurgy and ore dressing as applied to zinc ores, and finally a summary of the domestic and foreign conditions of the zinc industry.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each zinc smelting company in operation during 1912, except one small plant using both ore and skimmings, which refused to report.

[1] In Mineral Resources for 1906, p. 461, zinc derived from ore was called "primary" spelter to distinguish it from the secondary spelter recovered from such sources as drosses, skimmings, and old metal. The former has also been called "virgin" spelter, and the latter has been called "remelted," "reclaimed," and "dross" spelter. The distinctive origin is more plainly suggested by the terms "primary" spelter and "secondary" spelter, and they are used herein. The terms have no reference whatever to the qualities of the product. Where the word "spelter" is used without qualification primary spelter will be understood.

For this company a close estimate of the spelter made from ore, amounting to only a few hundred tons, has been obtained. Statistics of the recovery of secondary zinc were collected from all the important secondary smelters and refiners. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, and the tables for foreign production and consumption were compiled from the sources indicated.

STATE OF ZINC INDUSTRY IN 1912.

The production of primary spelter from domestic ores in 1912 was 323,907 short tons, valued at $44,699,166, based on the average St. Louis price, as compared with 271,621 short tons, valued at $30,964,794, based on the average St. Louis price, in 1911—a gain of 52,286 tons, equal to 19.2 per cent in quantity, and of $13,734,372, equal to 44.4 per cent in value.

The total production of spelter from both domestic and foreign ores in 1912 was the greatest in the history of the zinc-smelting industry of the United States, being 338,806 short tons, as against 286,526 tons in 1911, a gain of 52,280 tons, or 18.2 per cent. Along with this increase in production there was a large increase in the apparent consumption, which was more than 60,000 tons greater than the large consumption of 1911. This resulted in diminishing the stocks at smelters to 4,474 tons, the smallest stocks since 1906. The imports of spelter reached the highest figure in recent years, being over 10.000 tons greater than in 1911, while exports, both foreign and domestic, were less than in either of the two years preceding.

This condition was doubtless due to the generally prosperous state of the zinc industry, which resulted in an ascending scale of prices throughout the year and led to buying for future needs on the part of consumers. The normal stocks at smelters were thus converted into "invisible stocks" in the hands of the consuming interests, and the apparent consumption for the year doubtless greatly exceeds the actual consumption.

The total production of spelter is equivalent to the output of 79,719 average retorts operating continuously through the year on 60 per cent zinc concentrates. The retort capacity available for ore of the plants active in 1912 was, at the beginning of the year, 80,200 retorts. Many of them, of course, were used on low-grade ores, lessening their capacity. To these were added during the year 19,848 retorts, of which 2,880 were in Pennsylvania, 3,456 in West Virginia, 2,476 in Illinois, 10,796 in Oklahoma, and 240 in Colorado. Meanwhile there were slight reductions in capacity at certain plants, so that the total number of retorts available for smelting ore at the close of 1912 was 99,400. The large imports of spelter indicate that the active smelting capacity during the year was inadequate to the demands of a phenomenal apparent consumption. The United States retained first place in the world's production of spelter with 31.7 per cent of the total output.

The steady drain from Kansas smelting capacity for several years, owing to the failure of natural-gas fuel, has at last reduced that State

to second place as a zinc-smelting center. Oklahoma now holds first place in active smelting capacity, with 27,416 retorts; Kansas is second, with 27,092 retorts; and Illinois third, with 25,148. The largest smelter is the Collinsville (Okla.) plant of the Bartlesville Zinc Co., with 8,064 retorts; the next largest is the Meadowbrook (W. Va.) plant of the Grasselli Chemical Co., with 6,912 retorts; and the third is the Collinsville (Okla.) plant of the Tulsa Fuel & Manufacturing Co., with 6,232 retorts. The Mineral Point Zinc Co.'s plant at Depue, Ill., will have 9,080 retorts when completed in 1913.

PRODUCTION.

ANNUAL PRODUCTION, 1873–1912.

The production of spelter in the United States began in 1858 in an experimental way[1] and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiesson & Hegeler works in the West. Between 1864 and 1870 nine or ten other zinc smelters were established. Statistics of production are recorded for the years 1873 and 1875 and for the census year ending May 31, 1880. Annual statistics have been collected by the United States Geological Survey since 1882. The annual progress of the zinc-smelting industry since 1873 is shown in the following table:

Annual production of spelter in the United States from domestic and foreign ores, 1873–1912, in short tons.

Year.	From foreign ore.	From domestic ore.	Total.	Year.	From foreign ore.	From domestic ore.	Total.
1873	.....	7,343	7,343	1896	.....	81,499	81,499
1875	.....	15,833	15,833	1897	.....	99,980	99,980
1880	.....	23,239	23,239	1898	.....	115,399	115,399
1882	.....	33,765	33,765	1899	.....	129,051	129,051
1883	.....	36,872	36,872	1900	.....	123,886	123,886
1884	.....	38,544	38,544	1901	.....	140,822	140,822
1885	.....	40,688	40,688	1902	.....	156,927	156,927
1886	.....	42,641	42,641	1903	.....	159,219	159,219
1887	.....	50,340	50,340	1904	.....	[a] 186,702	186,702
1888	.....	55,903	55,903	1905	.....	[a] 203,849	203,849
1889	.....	58,860	58,860	1906	25,076	199,694	224,770
1890	.....	63,683	63,683	1907	26,115	223,745	249,860
1891	.....	80,873	80,873	1908	19,675	190,749	210,424
1892	.....	87,260	87,260	1909	25,535	230,225	255,760
1893	.....	78,832	78,832	1910	16,705	252,479	269,184
1894	.....	75,328	75,328	1911	14,905	271,621	286,526
1895	.....	89,686	89,686	1912	14,899	323,907	338,806

[a] Including an unknown quantity smelted from foreign ore, small in 1904 but larger in 1905.

[1] Ingalls, W. R., Lead and zinc in the United States, p. 314.

PRODUCTION BY STATES.

Production of primary spelter in the United States in 1906–1912, apportioned according to source of ore, in short tons.

Source.	Quantity.							Percentage of total in 1912.
	1906	1907	1908	1909	1910	1911	1912	
Arizona	64	77	152	2,862	2,594	2,476	4,092	1.26
Arkansas	1,801	1,911	2,002	135	286	385	604	.19
California	.....	140	27	.....	.....	959	1,672	.52
Colorado	32,456	26,077	24,885	20,121	23,238	42,233	60,841	18.78
Idaho	573	3,508	581	901	3,454	3,180	6,800	2.10
Illinois	282	1,446	298	675	1,551	2,884	3,952	1.22
Iowa	201	220	516	.....	40	.....	.....	.....
Kansas	3,902	13,850	8,628	9,185	10,220	6,843	5,668	1.75
Kentucky	335	358	341	22	29	205	394	.12
Maine	.....	1	.....	.....	.....	.....	.....	.....
Missouri	130,348	141,824	123,655	140,676	140,652	127,540	149,557	46.17
Montana	1,415	.....	900	4,725	12,408	22,115	14,196	4.38
Nevada	1,768	1,692	398	825	1,516	1,595	6,132	1.89
New Jersey	11,206	13,573	6,926	16,035	20,217	15,128	16,941	5.23
New Mexico	555	136	134	3,961	4,911	3,778	6,882	2.13
Oklahoma	.....	719	2,235	3,008	2,297	2,247	2,041	.63
Tennessee	124	181	341	695	925	1,000	1,935	.60
Texas	8	16	.....	.....	.....	.....	245	.08
Utah	2,449	1,972	282	5,960	7,221	7,004	7,756	2.39
Virginia	1,143	771	910	58	1,168	228	62	.02
Washington	7	.....	.....	.....	.....	12	.....	.....
Wisconsin	11,057	15,273	17,538	20,381	19,752	31,809	34,137	10.54
Total from domestic ores	199,694	223,745	190,749	230,225	252,479	271,621	323,907	100.00
Foreign:								
Canada	201	545	2,425	978	3,304	1,598	4,199	.....
Mexico	24,875	25,570	17,250	24,557	13,401	13,307	10,700	.....
Total from foreign ores	25,076	26,115	19,675	25,535	16,705	14,905	14,899	.....
Grand total	224,770	249,860	210,424	255,760	269,184	286,526	338,806	.....

Two tabulations of the spelter production of the country for a period of years are given, one showing the locality from which the ores were derived, the other the locality in which they were smelted. Each method has its special interests and advantages, depending on whether the viewpoint be that of producer or consumer or that of resources.

The State totals as given are compiled entirely from confidential reports by each company engaged in smelting zinc ores in the United States in the year in question. Only primary spelter is here included, the recovery of secondary spelter being given in a later table.

The foregoing table shows the sources of all ores and concentrates smelted for spelter in the United States in 1906–1912 and the quantity of spelter actually derived from the ores from these respective sources. Statistics of production according to source of ore were not collected prior to 1906.

The subjoined table shows the localities in which spelter was made.

Production of spelter in the United States, 1873–1912, apportioned according to locality in which smelted, in short tons.

Year.	Illinois.	Kansas.	Missouri.	Oklahoma.	Eastern.	Southern.	Colorado.	Total.
1873								7,343
1875	6,678	600	4,650		3,305			[a] 15,833
1880 (census)	10,904	2,451	5,671		4,213			23,239
1882	18,201	7,366	2,500		5,698			33,765
1883	16,792	9,010	5,730		5,340			36,872
1884	17,594	7,859	5,230		7,861			38,544
1885	19,427	8,502	4,677		8,082			40,688
1886	21,077	8,932	5,870		6,762			42,641
1887	22,279	11,955	8,660		7,446			50,340
1888	22,445	10,432	13,465		9,561			55,903
1889	23,860	13,658	11,077		10,265			58,860
1890	26,243	15,199	13,127		9,114			63,683
1891	28,711	22,747	16,253		8,945	4,217		80,873
1892	[b] 31,383	24,715	16,667		9,582	4,913		87,260
1893	[b] 29,596	22,815	13,737		8,802	3,882		78,832
1894	[b] 28,972	25,588	11,992		7,400	1,376		75,328
1895	[b] 35,732	25,775	14,998		9,484	3,697		89,686
1896	[b] 36,173	20,759	14,001		8,139	2,427		81,499
1897	[b] 37,876	33,396	18,125		7,218	3,365		99,980
1898	[b] 47,103	40,132	19,533		8,631			115,399
1899	[b] 50,118	52,021	18,107		8,805			129,051
1900	[b] 38,750	62,136	14,741		8,259			123,886
1901	[b] 44,896	74,240	13,083		8,603			[a] 140,822
1902	[b] 47,096	86,564	11,087		12,180			[a] 156,927
1903	[b] 47,659	88,388	9,994		12,301		877	[a] 159,219
1904	47,740	107,048	12,150		14,893		4,871	[a] 186,702
1905	46,606	114,287	11,844		24,513		6,599	[a] 203,849
1906	47,939	129,564	11,077		29,930		6,260	224,770
1907	56,056	134,108	11,732	5,035	37,626		5,303	249,860
1908	50,244	99,298	10,201	14,864	32,738		3,079	210,424
1909	67,653	103,299	7,037	28,782	42,941		6,048	255,760
1910	73,038	105,697	5,571	34,760	43,606		6,512	269,184
1911	83,130	98,413	4,116	46,315	47,155		7,397	286,526
1912	88,397	101,104	7,085	76,925	56,252		9,043	338,806

[a] Secondary spelter included: 600 tons in 1875; 2,716 tons in 1901; 2,675 tons in 1902; 3,302 tons in 1903; 3,300 tons in 1904; and 1,469 tons in 1905.
[b] Includes also the production of smelters in Indiana.

Owing to the fact that this chapter can not be prepared for publication until the latter part of the year and after the figures of the mid-year spelter statement are available, those figures were utilized in the following table of production by States for six-month periods, though they include one period in advance of the volume for the year:

Production of spelter in the United States, 1911–1913, by six-month periods, apportioned according to locality in which smelted, in short tons.

State.	Jan. 1 to June 30, 1911.	July 1 to Dec. 31, 1911.	Jan. 1 to June 30, 1912.	July 1 to Dec. 31, 1912.	Jan. 1 to June 30, 1913.
Illinois	41,255	41,875	44,224	44,173	53,524
Kansas	50,574	47,839	52,485	48,619	42,645
Oklahoma	19,997	26,318	36,010	40,915	43,253
All other States	28,370	30,298	33,777	38,603	40,791
Total	140,196	146,330	166,496	172,310	180,213

The following curves show graphically the production and consumption of spelter in the United States in the period for which there is record. The curves are made up of 9-year averages; that is, the point in the curve representing each year is the average of the actual quantity for the year as well as of the four years preceding and the four years following that year. This method practically eliminates the effects of temporary factors affecting the production or

consumption for one or two consecutive years. The resulting curves therefore approach the true curves of normal production and consumption. Naturally the smoothing effects of the method are less pronounced near the ends of the curves, which remain more or less irregular. No distinction is made between spelter of domestic and of foreign origin in this table. From the beginning of the period until 1888 the average consumption exceeded production. Since that year the average production has always exceeded the average consumption. The consumption figures, as taken, disregard all stocks.

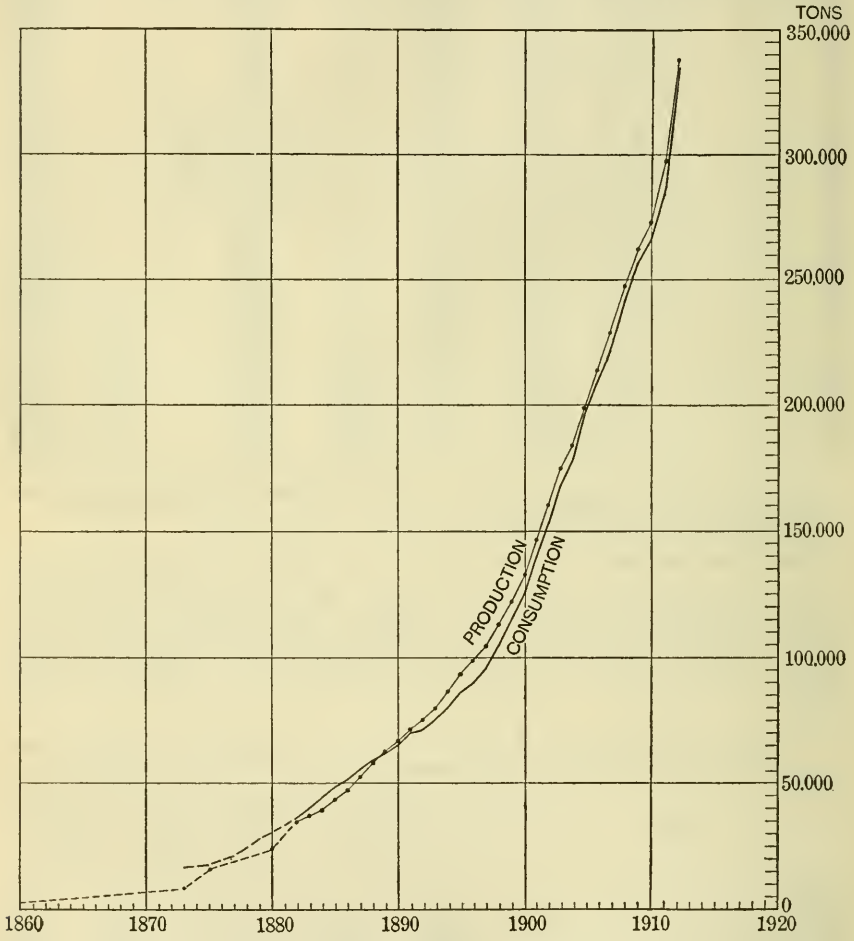

FIGURE 6.—Curves of spelter production and consumption, 1873–1912.

ZINC DUST.

Zinc dust is an impalpable powder which forms in the distillation of zinc when the zinc vapor is cooled too rapidly in the condensers or is diluted by too large a volume of other gas. It may constitute a large proportion of the metallic zinc obtained in electrothermic zinc smelting, but in ordinary retort smelting it usually amounts to between 3 and 10 per cent of the reduced zinc. The powder con-

sists of metallic zinc with about 10 per cent zinc oxide, which probably exists as a film surrounding the metallic particles. These particles can not be made to coalesce by heating unless under great pressure, but must be again vaporized and condensed. Marketable zinc dust must not contain more than 10 per cent of zinc oxide and must pass through a screen of 100 meshes to the inch.

Zinc dust differs from metallic zinc in other physical properties, such as rapid oxidation, absorption of hydrogen, and generally greater chemical activity, resulting at times in spontaneous combustion or explosion. These properties are believed by Sang [1] to be due to conditions of stress resulting from rapid solidification, somewhat analogous to the condition in "Prince Rupert's drops."

These peculiar properties of zinc dust are the cause of many of its uses. Under the name of "indigo auxiliary" a paste of zinc dust is used to discharge locally the color in dyeing cotton goods, giving a white pattern on the background of dye. Zinc dust is used in fireworks and in making hydrogen for balloons. It is the basis of the various methods of dry galvanizing and is also used to furnish the zinc solution in electrozincing. One of the most important uses of zinc dust is as a substitute for zinc shavings in zinc precipitation in the cyanide treatment of gold and silver ores. For this purpose it is cheaper, quicker, more effective, and more convenient than zinc shavings, and the saving in cost is about one-third.

In American zinc-smelting practice heretofore the zinc dust has been charged back into the retorts, since under the former tariff if sold as dust it came into competition with foreign zinc dust admitted free of duty, whereas recovered as spelter it was protected by an import duty of 1½ cents per pound. Hence the small quantity of zinc dust heretofore used in this country has been imported from Belgium and Germany. The tariff act of 1909, as shown on a later page, established an import duty upon zinc dust of 1⅜ cents per pound, and the tariff act of 1913 changed this to 15 per centum ad valorem.

A new ruling of the Interstate Commerce Commission lists zinc dust and zinc flue dust as inflammable solids and directs that they must bear a yellow shipping label. Paragraph 1834 of the ruling covering this product reads as follows: "Packages must be tight and strong, and the interior packages must be so cushioned and secured that no rupture of either package can result from the ordinary shocks incident to transportation."

The United States Zinc Co. about the middle of 1910 began the preparation of zinc dust for market in the smelter at Pueblo, Colo. The market is mainly western, and the product is used for zinc-dust precipitation in cyaniding in South Dakota, Nevada, and elsewhere. The Grasselli Chemical Co., with zinc-smelting plants at Clarksburg and Meadowbrook, W. Va., also has prepared zinc dust for market since 1911.

As there are but two producers the quantity and value of the output may not be disclosed, but it has been included in the zinc content of pigments in the following sections. For imports and prices, see under those headings in later sections of this report.

[1] Sang, Alfred, Old and new methods of galvanizing: Proc. Eng. Soc. Western Pennsylvania, vol. 23, 1907, pp. 546–571.

ZINC PIGMENTS.

There are four white pigments which have zinc for a base, either in whole or in part—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. All of these may be, and in the United States the first three usually are, made directly from ore.

Zinc oxide is the most important of these pigments. In European practice the oxide is made from spelter, though in France zinc oxide is made from ore in the electrothermic furnace invented by Côte and Pierron. In the United States the oxide is generally made from ore, but in 1912 of the total production, 5,959 tons were made from spelter, as compared with 3,922 tons in 1911. The production of zinc oxide in 1911 and 1912 may not be disclosed. In 1910 it was 59,333 short tons, as compared with 68,974 tons in 1909 and with 57,237 tons in 1908. The imports for consumption of zinc oxide in 1912 were 2,938 short tons, and the exports for the same period were 17,064 short tons.

Lead zinc oxide and zinc-lead oxide are produced from ore, both in some places at the same plant, the zinc-lead containing somewhat the larger percentage of lead. No zinc-lead oxide has been made since 1909. The production of leaded zinc pigment in 1911–1912 may not be disclosed, but in 1910 it was 7,111 short tons.

Lithopone is an intimate mixture by chemical precipitation of zinc sulphide and barium sulphate. It may be manufactured from spelter or zinc oxide, but in the United States it is now generally made from zinc skimmings, ashes, and scrap.

The zinc content of the various zinc pigments made in the United States in 1912 from ore, both domestic and foreign, was 62,876 short tons as compared with 46,376 tons in 1911, with 50,660 tons in 1910 and with 54,139 tons in 1909. The quantities given for 1910 and later years include the zinc contents of the zinc dust produced during those years, which may not be disclosed separately, there being at present but two producers.

For further details of the production of zinc pigments the reader is referred to the chapter on mineral paints in Part II of Mineral Resources for 1912.

SECONDARY ZINC.

In the ordinary method of galvanizing, where the material to be coated is dipped into a bath of molten zinc, there is great loss of zinc in the form of semioxidized skimmings and of hard zinc drosses, caused by the alloy formed by the zinc with the iron of the tank and of the article being galvanized. In the larger galvanizing plants there are furnaces to refine these skimmings and drosses and to recover the spelter. There are also many small plants and some large ones which make a practice of buying galvanizers' skimmings and drosses and of recovering the spelter. A considerable quantity of old metal in the form of various alloys of zinc with copper and other metals is also worked over and brought up to the desired composition by the addition of new metal. At almost every brass foundry and machine shop in the country it is the custom to remelt and use brass filings, grindings, and scrap copper and brass, and it is manifestly impracticable to attempt to take full account of such material. Some of the zinc smelters running on ore find it advantageous to work in a quantity of secondary material. In such cases they have made the

proper returns to the United States Geological Survey, and account has heretofore been taken of such production in these reports as dross or secondary spelter. As such spelter has been recovered by redistillation, it is practically indistinguishable in quality from spelter of ordinary grades made from ore. Several secondary smelters recovering zinc from drosses do so by redistillation. It has seemed advisable that the secondary spelter recovered by redistillation should be separated from that recovered by remelting, and it has accordingly been done in the table below.

The successful operation of an electric furnace for the refining by redistillation of zinc drosses is described in the section on metallurgy on a later page.

Since 1907 statistics have been collected from the secondary smelters and refineries, for the first two years by the writer and since by J. P. Dunlop, of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged, since which time the number of firms has been increased from about 40 to double that number, with a large increase in reported production. The following table gives the production of secondary zinc in the United States, and a later table gives the production of secondary spelter in Europe:

Production of secondary zinc in 1907–1912, in short tons.

	1907	1908	1909	1910	1911	1912
Secondary spelter, redistilled	7,050	7,159	9,273	12,784	14,043	26,064
Secondary spelter, remelted	11,791	9,811	23,767	28,439	26,470	26,187
Recovered zinc in alloys, excluding old brass remelted	1,417	665	1,181	2,709	3,223	3,912
Recovered zinc in remelted brass	(a)	(a)	8,204	18,450	24,110	28,426
Secondary zinc recovered as metal	20,258	17,635	42,425	62,382	67,846	84,589
Secondary zinc recovered in pigment	863	1,091	2,154	2,646	3,036	4,619
Secondary zinc recovered in zinc chloride b	4,411	4,500	3,839	3,970	3,865	4,903
Total secondary zinc	25,532	23,226	48,418	68,998	74,747	94,111

a Statistics not collected.
b These figures include only the quantity of zinc in zinc chloride used in wood preservation treatment, and were furnished by courtesy of the Forest Service, Department of Agriculture.

Besides the increased recovery of secondary zinc as spelter and in alloys as shown in this table, there was increased use of zinc skimmings and drosses in the manufacture of zinc pigments and lithopone and about the same quantity in zinc chloride. The zinc content of pigments and lithopone made from secondary zinc in 1912 was 4,619 tons, as compared with 3,036 tons in 1911 and with 2,646 tons in 1910. The zinc content of zinc chloride manufactured from secondary zinc and used in the treatment of railroad ties, bridge timbers, etc., in 1912, is estimated at 4,903 tons, as against 3,865 tons in 1911 and 3,970 tons in 1910.

The exports of zinc dross fell of almost completely. They were 205 tons, as compared with 4,246 tons in 1911, with 4,724 tons in 1910, with 7,069 tons in 1909, with 8,405 tons in 1908, with 9,593 tons in 1907, and with 15,887 tons in 1906, thus supplementing the figures of increased recovery of secondary zinc. It was to be expected that exports of zinc dross would cease altogether in time, as the zinc content is normally worth more in this country than abroad because of the import duty on zinc.

COMPARISON OF STATE TOTALS, BASED ON SMELTER AND ON MINE REPORTS.

The foregoing figures of the production of spelter by the respective States are compiled from reports from individual zinc smelters. For several years the production of the more valuable metals in the Western States has been also obtained by the United States Geological Survey from reports of individual mines, and since 1907 this has been extended over the whole country. In order to put the spelter production on the same basis as the mine figures, all the zinc which is manufactured into pigment directly from ore (excluding the quantity in zinc oxide manufactured from spelter, the inclusion of which would entail its duplication in the totals) is added to the production of metallic zinc. The zinc dust recovered during the year is also included here. The zinc recovered from secondary sources is excluded, since it has already been once reckoned as spelter. These facts must be borne in mind in comparing this table with the table showing the production of spelter. The State totals obtained by each method are compared in the following table:

Comparison of State totals of production of zinc, 1907–1912, based on smelter and mine reports, in short tons.

State.	1907				1908			
	Totals based on smelter reports.	Totals estimated from mine reports.	Differences.		Totals based on smelter reports.	Totals estimated from mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Arizona	89	114	.....	25	152	339	.....	187
Arkansas	1,911	474	1,437	.....	2,002	605	1,397	.....
California	140	116	24	.....	27	0	27	.....
Colorado	33,644	26,394	7,250	.....	29,907	15,065	14,842	.....
Idaho	3,508	3,493	15	.....	581	19	562	.....
Illinois	1,468	737	731	.....	298	1,717	.....	1,419
Iowa	220	145	75	.....	516	395	121	.....
Kansas	13,850	17,772	.....	3,922	8,628	14,119	.....	5,491
Kentucky	385	0	385	.....	341	0	341	.....
Maine	1	0	1	.....	0	0	.....	.....
Missouri	142,024	116,752	25,272	.....	123,655	107,404	16,251	.....
Montana	0	122	.....	122	900	820	80	.....
Nevada	1,692	1,084	608	.....	398	558	.....	160
New Jersey	59,588	69,369	.....	9,781	47,643	67,165	.....	19,522
New Mexico	1,038	375	663	.....	616	1,788	.....	1,172
Oklahoma	719	1,657	.....	938	2,235	4,529	.....	2,294
Tennessee	181	109	72	.....	341	344	.....	3
Texas	16	22	.....	6	0	18	.....	18
Utah	2,447	2,726	.....	279	282	730	.....	448
Virginia	771	0	771	.....	910	705	205	.....
Wisconsin	16,984	18,490	.....	1,506	18,598	18,206	392	.....
Total	280,676	259,951	.....	.....	238,030	234,526	.....	.....

Comparison of State totals of production of zinc, 1907–1912, etc.—Continued.

State.	1909				1910			
	Totals based on smelter reports.	Totals estimated from mine reports.	Differences.		Totals based on smelter reports.	Totals estimated from mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Arizona	2,862	2,989	.....	127	2,594	2,742	.....	148
Arkansas	135	510	.....	375	286	994	.....	708
California	0	0	.....	.....	0	0	.....	.....
Colorado	23,374	25,605	.....	2,231	25,883	38,545	.....	12,662
Idaho	901	676	225	.....	3,454	2,802	652	.....
Illinois	675	2,163	.....	1,488	1,551	3,549	.....	1,998
Iowa	0	35	.....	35	40	96	.....	56
Kansas	9,185	11,445	.....	2,260	10,220	13,229	.....	3,009
Kentucky	22	56	.....	34	29	6	23	.....
Missouri	140,811	130,162	10,649	.....	140,653	128,589	12,064	.....
Montana	4,725	4,680	45	.....	12,417	15,819	.....	3,402
Nevada	825	1,507	.....	682	1,551	1,354	197	.....
New Jersey	63,307	82,510	.....	19,203	65,419	68,678	.....	3,259
New Mexico	5,216	6,543	.....	1,327	5,889	9,044	.....	3,155
Oklahoma	3,008	7,806	.....	4,798	2,297	6,394	.....	4,097
Tennessee	695	596	99	.....	925	966	.....	41
Texas	0	0	.....	.....	7,288	8,184	.....	896
Utah	5,960	4,930	1,030	.....	1,168	794	374	.....
Virginia	58	58	.....	.....	.....	.....	.....	.....
Wisconsin	21,414	23,152	.....	1,738	21,475	25,927	.....	4,452
Total	283,173	305,423	.....	.....	303,139	327,712	.....	.....

State.	1911				1912			
	Totals based on smelter reports.	Totals estimated from mine reports.	Differences.		Totals based on smelter reports.	Totals estimated from mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Arizona	2,476	2,281	195	.....	4,092	4,379	.....	287
Arkansas	385	664	.....	279	604	748	.....	144
California	959	1,404	.....	445	1,672	2,173	.....	501
Colorado	45,093	47,304	.....	2,211	65,544	66,111	.....	567
Idaho	3,180	4,170	.....	990	6,824	6,953	.....	129
Illinois	2,884	4,219	.....	1,335	3,952	4,065	.....	113
Kansas	6,843	10,272	.....	3,429	5,668	10,633	.....	4,965
Kentucky	205	158	47	.....	394	491	.....	97
Missouri	127,601	122,515	5,086	.....	149,953	136,551	13,402	.....
Montana	22,115	21,905	210	.....	14,224	13,459	765	.....
Nevada	1,618	1,774	.....	156	6,271	6,661	.....	390
New Jersey	53,413	77,445	.....	24,032	70,444	69,755	689	.....
New Mexico	3,813	5,119	.....	1,306	7,635	6,783	852	.....
North Carolina	.....	.....	.....	.....	.....	142	.....	142
Oklahoma	2,247	5,150	.....	2,903	2,041	5,769	.....	3,728
Tennessee	1,000	1,117	.....	117	1,935	2,191	.....	256
Texas	.....	.....	.....	.....	245	119	126	.....
Utah	7,512	8,920	.....	1,408	8,220	8,534	.....	314
Virginia	314	[a] 1,113	.....	799	430	249	181	.....
Washington	12	10	2	.....	.....	.....	.....	.....
Wisconsin	33,359	29,720	3,639	.....	36,635	33,050	3,585	.....
Total	315,029	345,260	.....	.....	386,783	378,816	.....	.....

[a] Includes a small quantity of zinc from New York.

The smelter State totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, all pigments being recalculated back to equivalent metallic zinc on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of zinc ores and concentrates shipped, and from this the zinc content is reckoned by assay value. From that zinc

content 10 to 20 per cent, according to the character of the ore, is deducted for smelting losses, and the remainders thus obtained from all the producing properties in each State are combined to afford the totals for the respective States. Where the ore is concentrated at a custom mill, proper allowance is also made for the loss of metal in the process. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from each producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content and the theoretical recovery be correctly estimated. Theoretically, the State totals, as compiled from smelter reports and from mine reports, respectively, should in the long run agree closely. As a matter of fact, for any year they show considerable divergence. These discrepancies, giving rise to "smelter excess" or "mine excess," may be the result of one cause or of a combination of causes, among which are: Lag in the smelting of the ore, resulting in accumulation of ore stocks at the smelters; lag in the mining, owing to which the smelter depletes its ore stocks; error in calculating metallic content from assay and in estimating recovery; and error by smelters in exact distribution of spelter, by States, according to source.

Of these sources, the greater discrepancies arise from erroneous distribution by the smelters, in particular as among the States in the Joplin region and in the upper Mississippi Valley region. Smelters using ore from the Joplin region are prone to credit it to Missouri because bought through their agents at Joplin. Similarly, in the upper Mississippi region the ore is likely to be credited to Wisconsin because bought through a Wisconsin buyer. In each region there are companies operating in more than one State but selling ore through a central office—a condition which likewise leads to error in distribution. Another cause for such error, particularly in the upper Mississippi region, is found in the electrostatic and electromagnetic separation plants, the ore from which is naturally credited to the State in which the plant is located.

The smelter reports give the exact annual production of zinc and serve as a check on the mine production, and they also give the form in which the zinc was recovered, whether as spelter or as pigment. The distribution among States by the smelter reports has value as a check on the mine State totals, and also because of the earlier publication, but for exact distribution of zinc production according to origin, recourse must be had to the mine production reports.

MINE AND SMELTER TOTALS, 1912.

The mine excess in Kansas should be coupled with the mine excess in Oklahoma and is to be explained as due to the fact that spelter made from zinc ores from those States has been credited to Missouri by the smelters, and this likewise explains the large smelter excess in that State. The smelter excess in Montana, following a smaller one in 1911, probably represents depletion of smelter stocks and thus helps to dispose of the large mine excess in 1910. The smelter excess in New Jersey, following a mine excess in 1911, probably also represents depletion of stocks to that extent. The very considerable smelter excess in Wisconsin followed a similar smelter excess in

1911, but in both 1909 and 1910 there were mine excesses, so that the present excess probably in part represents depletion of smelter ore stocks, but it may be due in part to spelter made from Illinois ore being credited erroneously to Wisconsin by the smelters, as explained above.

RESOURCES.

UNITED STATES.

MINE PRODUCTION OF ZINC.

The following table shows, for each zinc-producing State, the total quantity of zinc ore produced, and the output of each kind of zinc ore. The column headed "All other ore" includes lead ore, copper ore, copper-lead ore, and dry or siliceous ore, no zinc of consequence being recovered from any of these except in Colorado. "Dry" ores produced in that State in 1912 contained 2,265 short tons of recoverable zinc. This, as in other States, was concentrated from parts of the ore from certain counties, however, and was not distributed through the whole of the "All other ore" credited to Colorado in 1912. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each zinc-producing State, so that a comparison may be made of the relative extent of deep mining operations for all five metals in these States, the quantity of crude ore raised being the best measure for this purpose. The table discloses the fact that Missouri made over one-fourth of the crude ore production of the zinc-producing States, having an output of 13,385,511 short tons of crude ore, of which 9,321,145 tons was zinc bearing. Excluding iron ore, this was the largest production of metalliferous crude ore in the United States. Next in rank was Michigan, with 11,411,941 tons of crude copper ore.

The table gives also the quantity of recoverable zinc contained in the crude ores of each State and the quantity of zinc recovered from each kind of zinc ore. The percentage of recoverable zinc contained in the zinc ore and the zinc-lead ore of each State is also shown. The recoverable zinc content of crude zinc ore ranges from 33.4 per cent in California down to 1.5 per cent in Missouri, the Western States having uniformly the higher percentage. The average recoverable zinc content of the zinc ore of the United States in 1912 was 2.6 per cent as against 2.7 per cent in 1911. Of the total mine production of zinc in 1912, a quantity corresponding to 88.4 per cent was derived from zinc ore, 11 per cent was derived from zinc-lead ore, and 0.6 per cent was recovered from all other ores. The figures of mine production of zinc are taken from the chapters on gold, silver, copper, lead, and zinc (mine production), in the various States as indicated in the prefatory note to this chapter.

Source of mine production of zinc in 1912, by States and kinds of ore, in short tons.

States.	Zinc ore.			Zinc-lead ore.			All other ore.		Total.	
	Crude ore.	Recoverable zinc content.	Per cent.	Crude ore.	Recoverable zinc content.	Per cent.	Crude ore.	Recoverable zinc content.	Crude ore.	Recoverable zinc content.
Arizona	22,321	3,828	17.2	4,190	551	13.2	6,813,571	.....	6,840,082	4,379
Arkansas	32,755	748	2.3	.....	.....	.....	.....	.....	32,755	748
California	6,472	2,160	33.4	.....	.....	.....	2,635,025	13	2,641,497	2,173
Colorado	177,946	42,495	23.9	229,107	21,339	9.3	2,169,573	2,277	2,576,626	66,111
Idaho	1,236	309	25.0	480,126	6,644	1.4	1,784,972	.....	2,266,334	6,953
Illinois	147,859	4,065	2.6	.....	.....	.....	.....	.....	[a] 147,859	4,065
Kansas	744,254	10,633	1.4	.....	.....	.....	.....	.....	744,254	10,633
Kentucky	[b] 12,000	491	4.1	.....	.....	.....	.....	.....	12,000	491
Missouri	9,321,145	136,551	1.5	.....	.....	.....	4,064,366	.....	13,385,511	136,551
Montana	136,552	13,431	9.8	91	28	30.8	5,415,521	.....	5,552,164	13,459
Nevada	7,394	2,108	28.5	20,054	4,553	22.7	4,736,517	.....	4,763,965	6,661
New Jersey	459,585	69,755	15.2	.....	.....	.....	.....	.....	459,585	69,755
New Mexico	16,394	4,012	24.5	15,792	2,771	17.5	1,320,100	.....	1,352,286	6,783
North Carolina	.....	.....	.....	1,215	142	11.7	14,858	.....	16,073	142
Oklahoma	293,500	5,769	2.0	.....	.....	.....	.....	.....	293,500	5,769
Tennessee	32,347	2,191	6.8	.....	.....	.....	603,229	.....	635,576	2,191
Texas	351	119	33.9	.....	.....	.....	20,757	.....	21,108	119
Utah	9,422	2,800	29.7	216,764	5,729	2.2	7,544,084	5	7,770,270	8,534
Virginia	2,132	236	11.1	2,803	[c] 13	0.5	1,160	.....	6,095	[c] 249
Wisconsin	1,363,636	33,050	2.4	.....	.....	.....	.....	.....	1,363,636	33,050
Total	12,787,301	334,751	2.6	970,142	41,770	4.3	37,123,733	2,295	50,881,176	378,816
Per cent of total zinc derived from each kind of ore	88.4			11.0			0.6		100.0	

[a] This is exclusive of the fluorspar ore mined in southern Illinois from which a small percentage of lead is recovered in milling.
[b] Estimated.
[c] Not all the zinc recovered from the zinc-lead ore was sold during the year.

BRIEF REVIEW OF ZINC-PRODUCING DISTRICTS.

For details of production in the various zinc-producing districts of the country the reader is referred to the mine reports for the individual States indicated in the prefatory note. This review is based on those reports or on notes furnished by the authors of the various reports. Only the general trend of development during the year will be here noticed in connection with the different districts.

EASTERN STATES.

New York became a producer of lead and zinc in 1911 for the first time in several years. The Northern Ore Co., operating the Edwards mine in 1912, did development work and continued experimental work upon the 50-ton mill in the magnetic separation of blende and pyrite. It was found that dry separation was unsatisfactory and a wet magnetic process was being developed.

The chief zinc-producing district in the eastern part of the United States is the famous Franklin Furnace region of New Jersey, embracing the great zinc deposits of Sterling Hill and Mine Hill. The former was mined continuously from about 1875 until 1900, and the latter is making near its maximum yield after over 60 years of active mining. Though the production of crude ore was increased over that of 1911, the total recoverable zinc content fell off considerably in 1912.

The Virginia-Tennessee area is the only other prominent zinc-producing region in the eastern part of the United States. The Virginia zinc mines had an output only about one-fourth as large in 1912 as in the preceding years. There were, however, some interesting developments, particularly in connection with the oxidized iron ores in Wythe County, where some zinc ore was recovered, and also in connection with the pyritic ores of Louisa County. The latter ores have always carried a certain quantity of lead and zinc, and at the Arminius mine the sulphide ores of these metals have at times been separated in a small way and shipped, though no shipments have been marketed in the last year or so. It is reported that very recently a new ore body has been struck at a depth of 1,000 feet, which consists of lead and zinc sulphides with a valuable silver content. It is further reported that other properties in line with the trend of these discoveries have been taken up by important zinc-smelting interests.

The zinc carbonate and blende deposits of eastern Tennessee assumed considerable importance in 1909 and 1910 owing to the reopening of some old mines and the entry into the district of the Grasselli Chemical Co., which obtained control of productive properties. In 1911 the American Zinc Co. of Tennessee, a subsidiary of the American Zinc, Lead & Smelting Co., took over the Holston mine at Mascot, as well as other properties, sank the Mascot shaft to a depth of about 400 feet, and began the construction of a 1,000-ton concentrating plant, which was completed in the first half of 1913. Notes on the equipment of this mill will be found under the heading "Metallurgy." Development work is reported to have proved up a large body of zinc ore, which is free from iron and lead and consequently suitable for the highest grade of spelter. An interesting discovery of the year was that of zinc ore, associated with the oxidized iron ores, in the old Embreeville iron mines in Washington County. Zinc carbonate ore has been shipped to the extent of a hundred carloads since the discovery of the deposits late in 1912.

North Carolina appeared as a zinc producer for the first time, with an output of 142 tons of zinc. This was obtained by the concentration and separation of zinc-lead sulphide ores from the Silver Hill mine of Davidson County.

CENTRAL STATES.

The upper Mississippi Valley region, embracing adjacent productive areas of Wisconsin, Illinois, and Iowa, had a smaller output of lead concentrates than in 1911, but made a gain in the production of zinc concentrates. The electrostatic zinc separator at Platteville, Wis., destroyed by fire late in 1911, has not been rebuilt, but the magnetic separating plant at Galena, Ill., burned at the same time, has been reconstructed with increased capacity. The concentration of the mining properties of the district into the hands of fewer interests continued during the year.

In the Kentucky-Illinois district the production of both lead and zinc concentrates was more than doubled over that of 1911. Lead is mostly produced in this district as a by-product in the concentration of the fluorspar ores. The large output in 1912 was a result, therefore, of the prosperity of the fluorspar industry, and was especially due to the large new mill at Rosiclaire. The zinc output was chiefly

of carbonate ore, but there was also a promising output of zinc-blende concentrates.

The Joplin region, embracing southwestern Missouri, southeastern Kansas, and northeastern Oklahoma, made a gain of over 10 per cent in the production of zinc concentrates, the total being 299,421 short tons, as compared to 268,670 tons in 1911. This is the greatest output since 1909, and in point of value is the greatest in the history of the district. The zinc content of the ore was 152,465 tons as against 137,633 tons in 1911. The gain was mostly made by Missouri, and in this gain the sheet-ground output and the soft-ground output showed about equally. The high price of zinc ore which prevailed during the year led to extensive operations in the sheet-ground, and the soft-ground mines in the vicinity of Thoms station and at Galena and Badger were stimulated to energetic operations. Development of the deeper levels at Miami, Okla., was continued and the territory north and east of the productive area was actively prospected.

Northern Arkansas made a slight gain in zinc production, more than half of which was the output of a single mine, the Red Cloud mine in the Rush Creek district. In spite of this fact the great activity in the shallow carbonate and silicate ore diggings in the vicinity of Zinc resulted in a considerable increase in the total number of shippers.

WESTERN STATES.

New Mexico produced about one-third more zinc in 1912 than in the preceding year, the exact figures of the recoverable metal content being 6,783 tons as against 5,119 tons in 1911. This zinc output is derived from the Kelly district in Socorro County, and from Luna, Grant, and Santa Fe counties. In addition to the magnetic separation and wet-concentration mill of the Tri-Bullion Co., the new concentration mill with flotation equipment of the Ozark Smelting & Mining Co. was completed and put in operation in 1913, so that the output for the coming year may show a considerable increase.

Colorado mines produced about 40 per cent more zinc in 1912 than in 1911. This was contained in carbonate ores, practically all from Leadville, and in zinc sulphide ores from Leadville and other districts. The output of carbonate ore at Leadville was 142,782 tons, averaging 29.2 per cent zinc, as compared with 83,905 tons in 1911. The mixed sulphide ores from Leadville and elsewhere were reduced to marketable zinc concentrates in roast magnetic separation plants at Breckenridge, Kokomo, Canon City, Denver, and in Eagle County, and also in the electrostatic separation plant at Silverton. The magnetic concentration plant near the mouth of the Yak tunnel, at Leadville, remained idle during the year.

In Montana the zinc production fell away over 40 per cent from the large production of 1911, the output being 13,459 tons as compared with 21,905 tons in 1911. This was on account of the idleness of the Elm Orlu mine, which was one of the two largest producers in the State in 1911. A zinc concentration plant is now under construction at Timber Butte (South Butte) to treat the ore from this mine. The first 500-ton unit of the new 1,000-ton concentrator of the Butte & Superior Co. was started up in June, 1912, and the second one later in the year. Additions in progress at the close of the year

to both the mill and the flotation plant will considerably increase the capacity in 1913. Prior to the completion of the new mill the ores from the Butte & Superior mine were treated at the Basin concentrator. Large increases in the zinc output of the Butte district are to be expected.

Idaho made record outputs of zinc ore and concentrates in 1912 when the production of zinc was 6,953 tons as compared to 4,170 tons in 1911. This increase of two-thirds was due mainly to larger shipments of concentrates from the Success and Morning mines, the product at the latter being of the Macquisten flotation plant, the capacity of which was doubled during the course of the year. Other flotation plants are in course of erection to treat zinc middlings in the Cœur d'Alene district.

The zinc production of Utah was 8,534 tons in 1912, against 8,920 tons in 1911. The Park City mining region alone produced 4,001 tons of zinc in 1912, about 47 per cent of the total zinc production of Utah. The Tintic district was also an important zinc producer, for the first time in the history of the district, and yielded 22 per cent of the zinc, or 1,855 tons, in 1912. The Bingham district was a large producer, but its output decreased from 2,358 tons in 1911 to 1,356 tons in 1912. Beaver, Tooele, and Juab counties also yielded some zinc.

The production of zinc in Arizona nearly doubled that of 1911, being 4,379 tons, as compared with 2,281 tons in 1911, and was derived mostly from Mohave County. The larger part came from the Golconda mine, which in September, 1912, was shipping at the rate of 1,200 tons of ore and concentrates a month. The ore from the other producing mine was concentrated in the electrostatic separator at Needles, Cal.

The zinc production of Nevada was four times as large as in the preceding year, being 6,661 tons, as compared with 1,774 tons in 1911. The Yellow Pine mine was the largest producer, shipping more than 1,000 tons of concentrates a month. The Potosi mine also had a large output.

California made a good increase in the production of zinc, the output being about 50 per cent greater than that of the previous year. There are but two producers, the Cerro Gordo mine, in Inyo County, and the Uncompahgre, in San Bernardino County. The Cerro Gordo mine, formerly operated as a lead mine, shipped zinc carbonate ore at the rate of 500 tons monthly during the greater part of the year.

MEXICO.

Zinc deposits are found in the Mexican States of Tamaulipas, Nuevo Leon, San Luis Potosi, Coahuila, and Chihuahua, but most of the ore imported into the United States has come from the two last mentioned.

Statistics of imports of zinc ore from Mexico based upon "consular invoice" or "declaration" are available as far back as 1904, as given on a later page. According to these returns the imports from Mexico were slightly less than in the preceding year, being 35,925 short tons, containing 14,206 tons of zinc, in 1912, as compared with 36,847 tons, containing 14,986 tons of zinc, in 1911. The quantities are smaller than in any year since 1905, due doubtless to the civil conflict in Mexico.

Certain changes in the Mexican railway tariffs, possibly designed in retaliation for the United States import duty, became effective at the beginning of 1910. The new schedule increased the rate from the zinc districts of northern Mexico to the United States $1.08 per ton and lowered that to Gulf ports $0.27 per ton. The difference in freight rates added to the United States import duty led to the consignment of several experimental lots of zinc ore to European smelters in the early part of 1910, but as yet there have been no shipments on a large scale.

CANADA.

The imports of zinc ore from Canada increased from 2,539 short tons in 1911 to 8,015 tons in 1912, owing no doubt to the high price of spelter in the United States during the year and to the reestablishment of concentration mills and railway facilities which had been destroyed by forest fires in 1911.

The zinc ore produced in British Columbia now finds its way to the zinc smelters of the United States. In the past the output of these ores has not assumed great importance, but there is no doubt of their extended occurrence, and should commercial success attend the efforts at reduction the district would become an important zinc producer.

A strong endeavor is being made in the Dominion of Canada to develop a commercially successful method of reducing the complex zinc ores of the Kootenay district of British Columbia. The Dominion Government appropriated $50,000 for experimental work, a preliminary report upon which is summarized in a later section on metallurgy. The preliminary part of the work having been completed in the laboratories of McGill University at Montreal by Dr. Alfred Stansfield, experiments on a larger scale are now proceeding at the electrothermic zinc smelter at Nelson, British Columbia.

AUSTRALIA.

The principal source of zinc in Australia is the silver-lead mines of Broken Hill, New South Wales. In the early days of Broken Hill mining the crude ore ran about 25 per cent each in lead and zinc and 25 ounces in silver, but by 1904 the average tenor had become reduced to 16 per cent each of lead and zinc with 11 ounces of silver to the ton. At present the average tenor is probably somewhat below those figures. In the effort to get rid of the zinc it was heaped up in enormous piles of zinc tailings and slimes from the concentrating plants, and lead concentrates with 20 per cent of zinc were smelted, lead slags averaging 16 per cent of zinc oxide with a maximum of 20 per cent having been run, according to Donald Clark.[1] Various leaching, electrolytic, and magnetic processes were successively tried and finally discarded for the flotation processes which have been in practical use since 1903. This method of concentration has the advantage that it can be applied to the current output of zinc tailings and slimes as well as to the accumulated stocks of those products.

The importance of flotation in that country is shown in the following table of the production of zinc concentrates at Broken Hill by flotation methods for the period 1907–1912, compiled from the annual

[1] Clark, Donald, Australian mining and metallurgy, Melbourne, 1904, p. 372.

reports of the department of mines of New South Wales. These concentrates are recovered from zinc middlings and tailings, both from the current product and from the stored accumulations of bygone years of milling operations. The minor quantities of lead concentrates recovered, as a table product from the zinc concentrates, are not included:

Production of zinc concentrates at Broken Hill, New South Wales, 1910–1912, in long tons.

Company.	Flotation process used.	1910		1911		1912	
		Tailings treated.	Concentrates.	Tailings treated.	Concentrates.	Tailings treated.	Concentrates.
Sulphide Corporation	Ballot	.....	80,401	.....	78,822	.....	71,040
Broken Hill Proprietary	Potter	279,150	69,855	422,511	103,378	316,441	88,008
Zinc Corporation	Minerals Separation.	270,637	85,625	331,486	103,630	345,425	85,354
Minerals Separation	Ballot	240,143	79,288	105,297	33,058	.....	.....
Amalgamated Zinc (De Bavay's).	De Bavay.	280,394	82,697	542,015	159,133	538,086	147,013
British Broken Hill	Elmore	33,428	9,622	.....	24,679	.....	27,298
Broken Hill Block 10	do	3,300	965	.....	.....	.....	.....
Total concentrates produced.		.....	397,866	.....	502,700	.....	418,713
Average zinc content, per cent.		.....	47.2	.....	46.0	.....	47.2

In 1903 the department of mines of New South Wales estimated the tonnage of stored zinc tailings and other zincky residues at 5,687,400 long tons, containing an average of 18.6 per cent of zinc. In 1908 the stocks of zinc tailings were estimated by different authorities to amount to about 7,000,000 tons and to contain about 1,200,000 long tons of zinc, 350,000 tons of lead, and 40,000,000 ounces of silver. A correspondent of the Australian Mining Standard of April 6, 1910, puts the stock of tailings at 6,000,000 tons, the total capacity of the flotation plants when present plans are completed at about 31,000 tons weekly, and the current production of zinc tailings at 24,000 tons weekly. At this rate of excess of consumption over current production it would require about 16 years for the re-treatment plants to absorb the accumulated tailings. This estimate is contingent upon the continuation in the future of the present rate of production of the mines.

The subjoined table compiled from the annual reports of the department of mines of New South Wales shows the quantity and zinc content of zinc concentrates exported from New South Wales from 1904 to 1912:

Exports of zinc (spelter and concentrates) from New South Wales, 1904–1912, in short tons.

Year.	Concentrates.	Zinc content.	Year.	Concentrates.	Zinc content.
1904	64,514	24,996	1909	418,775	161,300
1905	115,956	34,313	1910	524,862	207,085
1906	114,984	37,438	1911	578,343	213,321
1907	264,601	85,842	1912	582,980	217,520
1908	309,044	127,515			

The following extract from a recent authoritative volume [1] describing the flotation concentration of ores in Australia is interesting in this connection:

There still remains untreated sufficient material to keep the present plants going until 1919, when the accumulated tailing should be exhausted. It is evident that the 1904 estimates of tonnage available were far short of the truth. It is not probable that there will be any further great increase in the annual production of zinc concentrate at Broken Hill. It seems more probable that the pinnacle of tonnage was reached in 1910, and that the production will decrease from now on until the accumulated tailing is finished. There should be no large drop in the total tonnage produced, because the Zinc Corporation, the Amalgamated Zinc, and the Broken Hill Proprietary have reserves of tailing that will last for several years to come. One large plant last year ceased operating, but its place was taken by two smaller ones. A steady, slow decrease in production may be expected, because most of these companies during their early struggles with the vagaries of the processes used their best material to make ends meet. They will probably make as much money out of their lower-grade material as they did out of the higher-grade material. When these immense piles are exhausted, which can be definitely predicted for 1919 or before, there will be a sudden drop in the zinc production of Broken Hill which should considerably disturb the world's zinc market. The present production of Broken Hill represents just about 20 per cent of the total world's production. It is a remarkable fact that this enormous increase in the production of a district which seven years ago produced practically no zinc has caused very little disturbance of the price. This was due to the fact that the high-grade Broken Hill zinc concentrate took the place of low-grade ores from many places in the world outside of the United States, and these latter low-grade mines simply ceased production because the low-grade material could not compete with the high-grade at the same metal price.

The material treated by these processes at Broken Hill is of comparatively high grade, averaging at present close to 18 per cent zinc, 6 per cent lead, and 7.5 ounces silver per long ton. In spite of these good assays the profits are not fabulous. After charging working cost, royalty to process owners, smelters' charges, and management, there is left, on an average, close to 12 shillings per ton treated. In the case of some of the companies this is further decreased by the prices paid to the mining companies for the tailing. The average price for all the tailing and slime sold by the mining companies to the treatment companies averages about 6 shillings per ton, leaving, on an average, not over 6 shillings per ton profit to the treatment companies when zinc is £23 per ton [5 cents per pound]. These are not the actual results of any one company, but are a fair average of the whole. Some of the companies increase this profit in favorable cases by anything up to 4 shillings per ton by the re-treatment of the flotation concentrate, by means of which re-treatment a good lead concentrate is taken out of the flotation concentrate. This lead concentrate represents about 50 per cent of the lead in the flotation concentrate. These figures mean that if the price of zinc dropped to £20 per ton the flotation plants would have to close down or else reduce the working cost or economize in some other quarter.

METALLURGY.

CONCENTRATION.

PROGRESS OF FLOTATION CONCENTRATION IN THE UNITED STATES.

A brief description of various ore flotation processes was given in Part I of Mineral Resources for 1908 (pp. 251–256), and to that summary the reader is referred for further information. Since that time, however, various improvements have been made in the different

[1] Hoover, Theodore J., Concentrating ores by flotation: Min. Mag., London, pp. 161–162, 1912.

processes, and new processes have been invented. Most of these, together with the Froment, Potter, Delprat, Cattermole, and Sulman, Picard & Ballot, and other processes have been acquired by the Minerals Separation Co. (Ltd.), and that company has recently been merged with the De Bavay Sulphide Process Co., thereby acquiring the rights to the patents of the latter company outside of Australia. The American rights of the Minerals Separation Co. are handled by the Minerals Separation Co. of America.

The complex nature of the zinc ores of the Butte district has made their successful concentration very difficult. The Butte & Superior Co., after adequate tests, installed the Hyde flotation process in the new concentrating plant erected at the mine during 1912. The essentials of the process as given herewith are furnished by the patent specifications (U. S. patent No. 922085):

> The pulp is mixed with acid before thickening in a tank. It has been found that adding the acid in advance cuts down the amount required and promotes the settlement of colloidal material, which may be further aided, if necessary, by adding copperas, alum, or some other coagulant. From the thickener the pulp is pumped to the first-treatment tank, where oil is added and the entire mass agitated. A float concentrate is then taken off, and the gangue goes to the second-treatment tank, where the process is repeated, and thence to the third-treatment tank, where the pulp is agitated and a third concentrate taken off. From this tank the gangue is discharged as a final tailing.
>
> There is considerable silica mixed with the first concentrates, so they are all recleaned in a second device, the concentrates from which are the final product, while the tailing is all sent back through the system again.

The results of operation of the process are given in the Engineering and Mining Journal,[1] from which are abstracted the following notes regarding the concentration plant. The plant consists of two units, each of 500 tons' capacity and each equipped with crushing plant, jigs, hydraulic classifiers, a slime plant for oil flotation, and Wilfley tables, which are used only to separate the lead from the zinc. The ore is first reduced by rolls to six mesh, and after jigging the tailings are reground to 40 mesh and the tailings from the fine jigs ground to 100 mesh and treated by oil flotation. The pulp is thickened to three parts water and one part ore and is mixed with a small quantity of oil and sulphuric acid and agitated.

The Minerals Separation Co. filed suit for infringement of patents controlled by that company against James H. Hyde and the Butte & Superior Co. On July 29, 1913, a decision was handed down in favor of the plaintiff. It is understood the case will be appealed to a higher court.

It is reported that contracts have been made for the installation of the Minerals Separation Co.'s process at the new Elm Orlu mill now under construction at Timber Butte (South Butte), Mont. This process is also being installed in one unit of the large Inspiration Consolidated mill in Arizona and in the mill of the Tennessee Copper Co., at Ducktown, Tenn.

The Macquisten flotation plant installed in 1910 at the Morning mill of the Federal Mining & Smelting Co., at Mullan, Idaho, to treat zinc-barite-siderite middlings from the tables and vanners has been doubled in capacity. Originally consisting of 120 Macquisten

[1] Eng. and Min. Jour., vol. 93, June 1, 1912, p. 1068.

tubes, a second unit, to utilize 128 tubes, was begun near the close of the year, and this when completed will more than double the capacity of the plant and enable it to handle 200 tons of feed per day.

A concentration plant of 40 tons' capacity was constructed near Park City, Utah, to re-treat tailings from that district to recover their lead and zinc content. Wilfley tables and Macquisten flotation tubes were installed.

The successful operation of the Macquisten process at the Morning mill led to experimental installations of other flotation processes in the Cœur d'Alene district, and as a result flotation plants using a hot acid process, said to be a modification of the Delprat process, are being installed at the Green Hill and at the Hercules mills. Similar processes are being tried out at other mines in the district where the presence of zinc has long been a difficulty. At present a sort of contest is on between the tube and the tank flotation processes, the former costing more to install, the latter being less permanent.

WET CONCENTRATION.

The American Zinc Co. of Tennessee constructed a 1,000-ton mill, which started up in June, 1913, at Mascot, Tenn. As this is one of the largest and most modern zinc mills, a brief description of it will be given. The headframe, power house, crusher house, jig room, and table house are all separate, except that the crusher house and jig room adjoin. The buildings have concrete foundations, steel superstructure, and are covered with galvanized iron. The machinery is electrically group driven. The electrical machinery consists of two 1,200-kilowatt generators, one 200-kilowatt generator, and 10 motors ranging from 20 to 150 horsepower. From the headframe the ore is delivered to a gyratory crusher, which reduces it to 4 inches, thence by belt conveyor to the crusher house and jig room, both equipped with machinery of the straight Joplin type, with the exception of a single bull jig. Either side of the crusher house and the jig room may be operated independently of the other. The fines from the jig room go to the two-story table house, each floor of which is equipped with two Skinner classifiers, three Wilfley tables, six James slime tables, dewaterers, settling cones, and slime tanks. The tailings from the jigs consist of finely crushed dolomitic limestone, and these are sold for road metal and railway ballast. The dolomitic slimes from the tables have a growing market for fertilizer for alfalfa fields.

SMELTING.

ELECTROTHERMIC ZINC SMELTING.

The experimental work authorized by the Government of the Dominion of Canada in the hope of finding a reduction process for the complex zinc sulphide ores of British Columbia has proceeded

at McGill University, Montreal, under the direction of Dr. Alfred Stansfield. A preliminary report by W. R. Ingalls, the consulting engineer, may be abstracted as follows:[1]

A large number of experiments have been made with several forms of furnaces, certain of which have been of rather elaborate construction, and with a variety of raw material.

Our early experiments were directed chiefly toward a discovery of the metallurgical conditions that have heretofore prevented a satisfactory condensation of zinc as molten spelter. While I can not say that these experiments have afforded us a complete explanation of these conditions, they have taught us a good deal, but in spite of the knowledge acquired we have been so far unable to master the difficulties.

We have, indeed, produced some small quantities of spelter, and in certain experiments have condensed a fairly large proportion as molten metal, but we have not yet been able to do that at will.

Our experiments have thrown light upon the principles of furnace design and have led us to condemn several types that we have tried. Our work has indicated that in order to achieve any material improvement over the ordinary practice of zinc smelting it is necessary to abandon certain features of the latter and contemplate continuous charging of the ore and reduction material and discharging the residuum without interfering with the process of distillation. These conditions introduce a multitude of preplexing difficulties that can be worked out only by tedious experimentation.

The preliminary laboratory experiments have been completed and experiments on a commercial scale are now under way at Nelson, British Columbia, using the experimental electrothermic smelter, formerly operated by the Canada Zinc Co.

In a paper read before the Canadian Mining Institute, March 8, 1912, Mr. Ingalls advances the rather pessimistic conclusion that electrothermic zinc smelting has no future, except under special conditions of extraordinarily cheap power, etc., until the crucial point has been accomplished of reducing and distilling the zinc and condensing commercial proportions of the latter as spelter.

On the other hand, Dr. Joseph W. Richards,[2] in a description of the Johnson electric zinc furnace, says that in usual retort practice 20 to 30 per cent of the zinc distilled is caught as zinc dust and must be recharged, and that Johnson obtained better results than these in the condenser attached to his 25-kilowatt experimental electric furnace. However, Ingalls[3] says that in good retort practice the proportion of zinc dust formed varies from 5 to 10 per cent of the total zinc distilled over.

ZINC SMELTERS.

The following table gives the zinc-smelting capacity of the United States as determined by a recent canvass. Those plants which have an "A" in the column headed "Acid plant" operate sulphuric-acid plants, either at the smelter or elsewhere as indicated in the footnotes.

[1] Canadian Min. Jour., Oct. 15, 1911, pp. 668–669.
[2] Trans. Am. Electrochem. Soc., vol. 19, 1911, pp. 311–316.
[3] Ingalls, W. R., Metallurgy of zinc and cadmium, New York, 1906, p. 205.

List of active zinc smelters in the United States, showing capacity in 1912, by companies and States.

Company and State.	Location.	Acid plant.	Retorts at close of 1912.	Additional retorts contemplated in 1913.
COLORADO.				
United States Zinc Co.	Pueblo.		1,920	
ILLINOIS.				
American Zinc Co. of Illinois	Hillsboro.	A	1,600	2,400
Collinsville Zinc Smelting Co.	Collinsville.		1,536	
Granby Mining & Smelting Co.	East St. Louis.			2,880
Hegeler Bros.	Danville.	A	1,800	1,800
Illinois Zinc Co.	Peru.	A	4,640	
Matthiesson & Hegeler Zinc Co.	La Salle.	A	5,256	876
Mineral Point Zinc Co.	Depue.	A	4,520	4,560
National Zinc Co.	Springfield.	A[a]	3,200	
Robert Lanyon Zinc & Acid Co.	Hillsboro.	A	1,600	
Sandoval Zinc Co.	Sandoval.		996	
Total.			25,148	12,516
KANSAS.				
American Zinc, Lead & Smelting Co.	Caney.		3,648	
Do.	Dearing.		3,840	
Chanute Zinc Co.	Chanute.		1,280	
Edgar Zinc Co.	Cherryvale.		4,800	
Granby Mining & Smelting Co.	Neodesha.		3,840	
Kansas Zinc Co.	Altoona.		3,300	
Do.	Gas.		[b] 2,520	
Do.	La Harpe.		640	576
Pittsburg Zinc Co.	Pittsburg.		910	
Prime Western Spelter Co.	Gas.		4,834	
Total.			29,612	576
MISSOURI.				
Edgar Zinc Co.	St. Louis.		2,000	
Nevada Zinc Co.	Nevada.		672	
Total.			2,672	
OKLAHOMA.				
Bartlesville Zinc Co.	Bartlesville.		5,184	
Do.	Collinsville.		8,064	
Lanyon-Starr Smelting Co.	Bartlesville.		3,456	
National Zinc Co.	do.		4,480	
Tulsa Fuel & Manufacturing Co.	Collinsville.		6,232	
Total.			27,416	
PENNSYLVANIA.				
New Jersey Zinc Co. (of Pennsylvania)	Palmerton.		5,772	
WEST VIRGINIA.				
Clarksburg Zinc Co.	Clarksburg.		2,736	
Grasselli Chemical Co.	do.	A[c]	5,760	
Do.	Meadowbrook.	A[c]	6,912	
Total.			15,408	
Total for all States.			107,948	13,092

[a] The National Zinc Co. has zinc-roasting furnaces at Argentine, Kans., where the sulphur gases are utilized in an acid plant, the roasted concentrates being shipped to the smelter at Springfield, Ill.

[b] Idle in 1912.

[c] The Grasselli Chemical Co. operates acid plants in connection with its zinc-roasting furnaces at Grasselli, Ind., Cleveland, Ohio, and Newcastle, Pa., the roasted zinc concentrates being shipped to the smelters at Clarksburg and Meadowbrook, W. Va.

From the 107,948 retorts listed above as in existence at the close of 1912 there should be subtracted 8,548 retorts at plants either idle during the year, or just completed at the close of the year, or en-

gaged in smelting secondary material, leaving 99,400 retorts as active during the latter part of the year. At an average of 4¼ tons of spelter per annum for each retort, working upon 60 per cent concentrates, this would give 395,728 tons as the active smelting capacity at the close of the year. On considering the quantity of low-grade ore smelted and the output for the year, 338,806 tons, it may be seen that the smelting capacity must have been crowded during the latter part of the year.

SMELTER CHANGES.

The Robert Lanyon Zinc & Acid Co. completed a smelter at Hillsboro, Ill., late in the year, which started up in 1913. It is equipped with 1,600 retorts and a plant for converting the roaster fumes into sulphuric acid. The company controls sufficient coal land to insure an adequate fuel supply.

The American Zinc Co. of Illinois, a subsidiary company of the American Zinc, Lead & Smelting Co., is building a new smelter and acid plant, also at Hillsboro, Ill. The first unit of 1,600 retorts started up late in 1912 and an additional 2,400 retorts will be added in 1913.

Hegeler Bros. are building, to be finished in 1913, an addition of 1,800 retorts, which will exactly double the capacity of their smelter at Danville, Ill. The acid plant will be correspondingly enlarged.

The Matthiesson & Hegeler Zinc Co. is building an addition of one block of 876 retorts with additional acid capacity also.

The Granby Mining & Smelting Co. is constructing a smelter, with 2,880 retorts and an acid plant, at East St. Louis, Ill. It is expected to be ready for operation late in 1913.

The Mineral Point Zinc Co. is building an addition to its smelter at Depue, Ill., which will more than double the capacity. The addition in 1913 of 4,560 retorts to the 4,520 retorts already in operation will give a total of 9,080 retorts in one plant, the largest zinc smelter in the United States. The completion of this addition and of the additions under construction at other plants, together with the new plant at Hillsboro and the new Granby plant at East St. Louis, will give Illinois a total of \$37,666 retorts, as against 30,188 retorts now active in Kansas.

It is authoritatively announced that the American Metal Co. (Ltd.) has formed a subsidiary company known as the American Zinc & Chemical Co., to build a large modern zinc smelter and acid plant at Langeloth, a town to be built near Burgettstown, Pa., about 25 miles west of Pittsburgh. An extensive tract underlain with the Pittsburgh coal seam has been purchased. The contract for structural steel is reported to have been let.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The world's production of spelter in 1912 was again the largest in history, exceeding that of the record output of 1911 by 83,984 tons, or 8.5 per cent. The greatest increase was contributed by the United States, which exceeded its production of 1911 by 52,280 tons, or 18.2 per cent. Germany made a gain of 22,786 tons, or 8.3 per cent.

France and Spain were third with a gain of 8,752 tons, or 12.4 per cent. Good gains were also made by Austria, Italy, Belgium, and Norway, the latter of which entered the producing ranks in 1911. Smaller gains were made by other countries, except Great Britain and Poland, which showed a decrease in production, the former of 10,720 tons, or 14.5 per cent, the latter of 1,293 tons, or 11.8 per cent. The output of the United States was 31.7 per cent of the total production of the world. The next largest producers were Germany, with 27.9 per cent of the world's production to its credit, and Belgium with 20.6 per cent.

The following totals, apportioned according to the country where smelted and not according to the source of the ore, are taken from the annual statistical publication for 1912 of the Metallgesellschaft, the Metallurgische Gesellschaft, A.-G., and the Berg und Metallbank Aktiengesellschaft, of Frankfurt-am-Main, Germany, except that the figures for the United States are those of the United States Geological Survey:

The worlds' production of spelter, 1905–1912, by countries, in short tons.

Country.	1905	1906	1907	1908	1909	1910	1911	1912
Australia	.....	1,131	1,098	1,198	.....	560	1,904	2,531
Austria and Italy	10,315	11,883	12,522	14,063	13,931	14,666	18,602	21,609
Belgium	160,496	168,067	170,307	181,851	184,194	190,233	215,050	220,678
France and Spain	55,524	59,293	61,438	61,512	61,859	65,191	70,791	79,543
Germany	217,356	225,997	230,058	239,062	242,594	251,046	276,008	298,794
Great Britain	56,140	57,971	61,286	60,029	65,422	69,531	73,806	63,086
Holland	15,176	16,150	16,526	19,017	21,548	23,121	25,059	26,380
Norway	.....	.....	.....	.....	.....	.....	7,363	8,959
Poland	8,422	10,595	10,735	9,740	8,758	9,514	10,952	9,659
United States	203,849	224,770	249,860	210,424	255,760	269,184	286,526	338,806
Total	727,278	775,857	813,830	796,896	854,066	893,046	986,061	1,070,045
United States percentage of world's production	28.0	29.0	30.7	26.4	29.9	30.1	29.1	31.7

PRODUCTION OF SECONDARY SPELTER IN EUROPE.

The following table of the production of secondary spelter in Europe is calculated to short tons from a table published by Rudolf Wolff, Kreuger & Co., of London. It includes the output of the larger regular producers only. The production of the United States is included for comparison.

Production of secondary spelter in Europe and United States, 1905–1912, in short tons.

Country.	1905	1906	1907	1908	1909	1910	1911	1912
Austria-Hungary	3,505	3,674	3,931	3,315	3,102	2,934	3,282	3,282
Belgium	4,044	4,473	3,620	4,295	3,564	3,406	3,288	4,138
France	14,304	14,898	15,130	20,309	20,467	20,691	24,345	25,077
Germany	9,689	11,040	11,316	13,273	14,943	15,133	16,022	21,093
Great Britain	7,913	7,644	7,168	8,714	8,454	7,605	9,296	7,963
Holland	2,268	2,800	2,957	2,923	2,184	2,610	2,722	3,730
Russia	1,680	.....	1,680	1,680	.....	224	1,184	1,353
United States	.....	.....	18,841	16,970	33,040	41,223	40,513	52,251
Total	43,403	44,529	64,643	71,479	85,754	93,826	100,652	118,887

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Zinc imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the zinc goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the zinc may be withdrawn for consumption by payment of duty, or it may be smelted in bond, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The zinc entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption, which are expressed in the same terms in which they were imported. The zinc imported for consumption may be actually used in the country or it may be manufactured and exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below showing foreign zinc exported in manufactures with benefit of drawback the zinc is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign zinc given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. A somewhat more detailed explanation of warehouse transactions is given in the chapter on lead in this volume. The following tables of imports and exports of zinc and of zinc remaining in warehouse are made up from the publications and records of the Bureau of Foreign and Domestic Commerce.

The quantity of zinc remaining in warehouse at the close of the years previous to 1909 has been negligible, but since all zinc ore became dutiable on August 6, 1909, the quantity of bonded zinc has largely increased.

Practically all the zinc remaining in warehouse, as shown in the table below, is credited to the port of Kansas City, Mo., and is in possession of the bonded zinc smelters of Kansas and Oklahoma.

Zinc remaining in warehouse Dec. 31, 1909–1912.

Year.	Ore and calamine.			Blocks, pigs, and old.	
	Short tons.	Zinc content.	Value.	Quantity.	Value.
		Pounds.		*Pounds.*	
1909	2,813	2,255,341	$36,384	78,667	$4,021
1910	2,603	2,572,122	61,730	61,146	3,406
1911	10,177	6,978,098	137,055	63,454	4,049
1912	3,076	2,479,565	62,089	.....	.....

The figures for 1910 are exclusive of 2,627,939 pounds of zinc contained in 10,359 short tons of other ore entered at New York and valued at $131,397, and the figures for 1911 are exclusive of 8,911,376 pounds of zinc contained in 36,038 tons of other ore, valued at $178,228, all of which zinc was lost in smelting the ore, as explained

later in the discussion of the general imports of zinc ore. In 1912 the duties assessed on such ores having been refunded they are not carried on the bonded warehouse records.

IMPORTS.

Zinc imported and entered for consumption in the United States, 1902–1912, in short tons.

Year.	Block or pigs.		Sheets.		Old.		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902	448	$36,536	68	$8,339	157	$8,299	$32,708	$85,882
1903	202	19,161	129	8,537	163	11,772	10,376	49,846
1904	341	34,211	17	2,230	36	3,247	10,394	50,082
1905	428	46,295	14	1,953	86	5,110	8,253	61,611
1906	1,021	240,632	22	3,236	79	7,647	2,904	254,419
1907	1,709	220,474	52	7,158	122	8,582	8,516	244,730
1908	776	78,160	37	4,570	37	2,014	5,645	90,389
1909	9,419	805,087	117	13,510	238	9,999	6,488	835,084
1910	989	95,410	255	36,741	73	5,685	1,526	139,362
1911	323	38,322	291	55,211	104	8,609	7,981	110,123
1912	10,719	1,239,574	728	102,073	147	13,748	8,489	1,363,884

The foregoing table does not include zinc dust imported for consumption. Prior to August 6, 1909, zinc dust was entered free of duty under "articles in a crude state used in dyeing and tanning," and as such was not separately enumerated in the general list of imports. Since the date mentioned zinc dust bears a duty of $1\frac{3}{8}$ cents per pound, and is separately enumerated under "imports for consumption," though included with spelter in the Monthly Summary of general imports. The imports for consumption of zinc dust for the period August 6 to December 31, 1909, were 431,660 pounds, valued at $19,464. This quantity and value is included in the total for the year as given in the table below. The quantity of zinc dust imported for consumption in 1910 and its value are also as given in the table. The only statistics available for the time before August 6, 1909, are those of foreign countries relating to their exports of zinc dust to the United States. Among these countries are Germany, Belgium, France, Holland, and Denmark, but only in the reports of the first-mentioned country are the exports of zinc dust segregated from other exports. Germany furnishes much the larger part, amounting to about 95 per cent of the total imports of zinc dust; for this reason the zinc-dust exports from Germany to the United States from March 1, 1906, to August 5, 1909, inclusive, as compiled from the annual Statistik des Deutschen Reichs, Auswärtiger Händel, and shown in the following table, give a fair idea of the total consumption of zinc dust in the United States for that period.

Imports of zinc dust, 1906–1912, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906[a]	1,818,576	$108,052	1910	2,985,088	$136,749
1907	1,893,090	106,386	1911	3,426,161	177,420
1908	2,625,238	136,136	1912	5,471,211	306,061
1909	2,520,740	130,662			

[a] March–December, 1906; for period preceding, zinc dust is not separately enumerated.

In view of the general interest in the importation of zinc ores, a table is given below, showing the entry of such ores from Mexico and Canada for 1904–1912 by calendar years. These general imports of zinc ores differ from "imports for consumption" by the difference in stock in bonded warehouse at the beginning and close of the year and by exports from warehouse.

Imports for consumption of zinc ore and calamine, 1909–1912.

Year.	Containing less than 10 per cent of zinc (duty, free).		Containing from 10 to 20 per cent of zinc (duty, ¼ cent per pound).		Containing from 20 to 25 per cent of zinc (duty, ½ cent per pound).		Containing 25 per cent or more of zinc (duty, 1 cent per pound).	
	Zinc content.	Value.	Zinc content.	Value.	Zinc content.	Value.	Zinc content.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1909 [a]	.....	.....	333,144	$8,690	225,302	$5,632	9,390,620	$161,430
1910	31,899	$698	174,697	4,053	2,355,748	25,126	39,921,939	713,684
1911	77,383	1,411	377,884	8,705	1,128,238	16,914	6,697,107	120,756
1912	44,308	1,141	112,938	3,045	916,865	6,734	12,875,485	281,066

[a] For period July 1–Dec. 31 only.

The statistics of general imports as published by the Bureau of Foreign and Domestic Commerce are based on "consular invoice" or "declaration," which is a close approximation only to actual weights and values. The true weights and values of all dutiable articles are determined when the duties are paid, and the correction is applied as "additions by liquidation" or "deductions by liquidation." On free articles this correction is not made. Prior to 1909 zinc ore was in large part undutiable, and in that part of 1909 prior to August 6 a portion of the imports of zinc ore was free. The correction by liquidation for the dutiable zinc ore imported during 1909–1912 is available, but, owing to special instructions followed in one customs district, to apply the correction by liquidation would result in a considerable duplication of imports. The following figures are taken directly from the Monthly Summary of the Bureau of Foreign and Domestic Commerce without the liquidation correction:

General imports of zinc ore from Canada and Mexico, 1904–1912, in short tons.

Year.	Canada.		Mexico.		Total.	
	Ore.	Zinc content.	Ore.	Zinc content.	Ore.	Zinc content.
1904	.....	.....	2,264	.....	2,264	.....
1905	4,063	.....	18,074	.....	22,137	.....
1906	423	.....	59,991	.....	55,414	.....
1907	1,112	.....	102,005	.....	103,117	.....
1908	7,406	.....	46,351	.....	53,757	.....
1909	10,024	.....	104,826	.....	114,850	.....
1910	4,749	1,922	67,818	23,517	72,626	25,439
1911	2,359	947	36,847	14,986	39,116	15,933
1912	8,015	3,661	35,925	14,206	43,940	17,567

The foregoing figures showing imports of zinc ore in 1910 do not include 10,431 short tons of ore that carried 2,645,111 pounds of zinc

as an accessory constituent, an average of less than 13 per cent, which was lost in smelting the ore and hence for the purpose of this report can not be classed with zinc ore imports so long as the present metallurgical treatment of that ore prevails. Similarly, the figures for 1911 are exclusive of 25,769 tons of other ore, carrying 6,283,437 pounds of zinc, and those for 1912 are exclusive of 18,245 tons of other ore, carrying 4,862,508 pounds of zinc. The duties on the zinc contents of this ore have since been refunded and the bonds canceled. The ore was shipped from South American ports and largely entered through the port of New York. It is shown in the Monthly Summary of the Bureau of Foreign and Domestic Commerce under the heading of "Merchandise remaining in warehouse," mostly at New York.

Zinc oxide imported and entered for consumption 1901–1912, in short tons.

Year.	Dry.	In oil.	Year.	Dry.	In oil.
1901	1,800	64	1907	2,656	181
1902	1,636	82	1908	2,318	105
1903	1,744	83	1909	3,060	268
1904	1,283	112	1910	3,069	168
1905	1,718	171	1911	2,506	274
1906	2,096	146	1912	2,675	262

Imports of old brass fit only for remanufacture, 1903–1912, in pounds.

[Average composition about one-third zinc and two-thirds copper.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	1,216,683	$154,260	1909	4,672,575	$579,454
1904	2,659,054	310,311	1910	6,144,564	785,684
1905	9,676,798	1,169,320	1911	3,605,106	445,116
1906	12,938,205	1,891,126	1912	6,596,957	639,045
1907	7,957,015	1,344,753			
1908	2,714,155	355,335	Total	58,181,112	7,674,404

EXPORTS.

DOMESTIC EXPORTS.

The practice of the Bureau of Foreign and Domestic Commerce is to class all exports of zinc articles made in this country as domestic exports, whether the zinc be of domestic or foreign origin. Hence, the following table of domestic exports is duplicated in part in a later table of foreign zinc in manufactures exported with benefit of drawback. The exports of zinc ore in the table below are of domestic origin and in recent years have all been from one mine in New Jersey. The exports of plates, sheets, pigs, or bars are likewise probably wholly domestic, since as shown later all the zinc in manufactures going out under drawback came in as blocks, pigs, and sheets, and the only manufacturing process which would put any of these into the class of exports referred to is rolling into sheets. But the zinc rolling mills in this country do not use foreign spelter, hence the conclusion that the plates, sheets, pigs, and bars of the table are of domestic origin. The zinc dross exports are no doubt in part of foreign

origin, but in what proportion can not be determined. However, they are not duplicated in the drawback table. The exports of manufactures, of which the value is given, include the value of the whole of the manufactures exported with benefit of drawback, as well as whatever manufactures of domestic zinc may be exported.

Exports of domestic zinc ore and of domestic manufactures of zinc, 1902–1912, in short tons.

Year.	Zinc ore.		Plates, sheets, pigs, or bars.		Zinc dross.[a]		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902....	55,733	$1,449,104	3,237	$300,557	.....	.....	$114,197	$1,863,858
1903....	39,411	987,000	1,521	163,379	.....	.....	71,354	1,221,733
1904....	35,911	905,782	10,147	1,094,490	.....	.....	117,957	2,118,229
1905....	30,946	848,451	5,516	682,254	.....	.....	159,995	1,690,700
1906....	27,720	733,300	4,670	583,526	15,887	$1,103,706	204,269	2,624,801
1907....	[b] 20,352	579,490	563	75,194	9,593	560,944	186,203	1,401,831
1908....	[b] 26,108	877,745	2,640	250,254	8,405	467,403	88,485	1,683,887
1909....	[b] 12,455	412,300	2,566	263,010	7,069	477,112	69,751	1,222,173
1910....	[b] 19,711	649,425	3,990	426,560	4,729	380,950	101,336	1,558,271
1911....	[b] 18,281	642,884	6,872	810,099	4,246	348,176	134,518	1,935,677
1912....	23,349	823,997	6,634	864,292	205	17,985	140,027	1,846,301

[a] Not separately enumerated prior to 1906.
[b] The exports consisted wholly of high-grade willemite ore from New Jersey.

Exports of zinc oxide, 1902–1912, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1902	5,358	$433,722	1908	12,008	$845,070
1903	7,215	578,215	1909	14,846	1,026,377
1904	8,157	628,494	1910	13,167	943,968
1905	11,280	810,203	1911	14,618	1,051,311
1906	15,578	1,149,297	1912	17,064	1,247,702
1907	13,257	1,069,924			

FOREIGN EXPORTS.

By foreign zinc exports is meant the exports of zinc of foreign origin which has been smelted or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total zinc exported from warehouse during the last six years, the exports previous to that period being of insignificant proportions, and also the foreign zinc exported in manufactures with benefit of drawback for the same period. These two items—foreign zinc exported from warehouse and foreign zinc in manufactures exported with benefit of drawback—make up the total foreign zinc going out of the country. Zinc in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of zinc and the total imports of zinc constitutes the foreign zinc consumed in this country. It must be clearly understood in regard to this table that the zinc was not exported as zinc content of ore and blocks, pigs, etc., but as zinc smelted or manufactured from them. The reason for this is that the zinc in bonded customs warehouse is carried on the records until the bond is canceled in the same form in which the zinc was entered for warehouse. The zinc content of the foreign

ore is, of course, exported as spelter. Under present customs regulations 90 per cent of the total zinc content must be exported to secure cancellation of bond. The quantities of zinc exported from warehouse are exact, but the quantities as given of zinc exported in manufactures under drawback are subject to wastage in manufacturing.

No record is kept of the form in which the zinc is actually exported, except of a portion of the articles manufactured from foreign zinc and exported with benefit of drawback. Unless the zinc is the constituent of chief value, the actual amount of zinc is not recorded. But each shipment on which drawback is claimed is accompanied by a manifest of the imported zinc which was used in making the articles as well as the duty paid thereon. From these manifests is made up the statement of the total quantity of foreign zinc which went into manufactures exported with benefit of drawback, and for this reason the zinc is given in the form in which it was imported.

Exports of foreign zinc, 1905–1912, in pounds.

Year.	Exported from warehouse.					Exported in manufactures with benefit of drawback.
	Ore and calamine, zinc content.[a]		Blocks, pigs, and old.		All other manufactures.	Blocks, pigs sheets, and all other manufactures.
	Quantity.	Value.	Quantity.	Value.	Value.	Quantity.
1905	.....	.....	38,753	$816	$1,015	.....
1906	.....	.....	2,779	252	1,962	4,469
1907	.....	.....	17,458	1,023	1,504	3,110,239
1908	.....	.....	16,748	964	4,635	2,468,365
1909	[a] 655,102	$6,429	12,569	752	521	610
1910	9,420,984	182,345	94,672	4,884	1,121	8,972,427
1911	21,636,946	476,233	915,823	21,141	2,701	6,157,328
1912	13,556,954	306,726	95,571	4,346	30,649	2,437,354

[a] After Aug. 6, 1909.

CUSTOMS DUTIES ON ZINC.

The tariff act of 1909 had the following sections relating to zinc ore, zinc, and to compounds containing zinc:

PAR. 55. Zinc, oxide of, and white pigment containing zinc, but not containing lead, dry, one cent per pound; ground in oil, one and three-fourths cents per pound; sulfid of zinc, white, or white sulphide of zinc, one and one-fourth cents per pound; chloride of zinc and sulphate of zinc, one cent per pound.

PAR. 193. Zinc-bearing ore of all kinds, including calamine, containing less than ten per centum of zinc, shall be admitted free of duty; containing ten per centum or more of zinc, and less than twenty per centum, one-fourth of one cent per pound on the zinc contained therein; containing twenty per centum or more of zinc and less than twenty-five per centum, one-half of one cent per pound on the zinc contained therein; containing twenty-five per centum of zinc, or more, one cent per pound on the zinc contained therein: *Provided*, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers,

who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample, and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

PAR. 194. Zinc in blocks or pigs and zinc dust, one and three-eighths cents per pound; in sheets, one and five-eighths cents per pound; in sheets coated or plated with nickel or other metal or solutions, one and three-fourths cents per pound; old and worn-out, fit only to be remanufactured, one cent per pound.

The tariff act of 1913 substituted ad valorem rates for specific duties and made the provision for smelting in bond applicable to all other metals as well as lead. The paragraphs relating to the various dutiable forms of zinc are as follows:

162. Zinc-bearing ores of all kinds, including calamine, 10 per centum ad valorem upon the zinc contained therein: *Provided*, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

163. Zinc in blocks, pigs, or sheets, and zinc dust; and old and worn-out zinc fit only to be remanufactured, 15 per centum ad valorem.

61. Zinc, oxide of, and pigments containing zinc but not containing more than 5 per centum of lead, ground dry, 10 per centum ad valorem; when ground in or mixed with oil or water, lithopone and white sulphide of zinc, 15 per centum ad valorem.

62. Zinc, chloride of and sulphate of, ½ cent per pound.

N. SUBSECTION 1. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals, may upon the giving of satisfactory bonds be designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there smelted or refined, or both, together with ores or crude metals of home or foreign production: *Provided*, That the bonds shall be charged with the amount of duties payable upon such ores and crude metals at the time of their importation, and the several charges against such bonds may be canceled upon the exportation or delivery to a bonded manufacturing warehouse established under paragraph M of this section of an amount of the same kind of metal equal to the actual amount of dutiable metal producible from the smelting or refining, or both, of such ores or crude metals as determined from time to time by the Secretary of the Treasury: *And provided further*, That the said metals so producible, or any portion thereof, may be withdrawn for domestic consumption, or transferred to a bonded customs warehouse, and withdrawn therefrom, and the several charges against the bonds canceled upon the payment of the duties chargeable against an equivalent amount of ores or crude metals from which said metal would be producible in their condition as imported: *And provided further*, That on the arrival of the ores and crude metals at such establishments they shall be sampled and assayed according to commercial methods under the supervision of Government officers, to be appointed by the Secretary of the Treasury and at the expense of the manufacturer: *Provided further*, That antimonial lead produced in said establishments may be withdrawn for consumption upon the payment of the duties chargeable against

it as type metal under existing law and the charges against the bonds canceled in a similar sum: *Provided further*, That all labor performed and services rendered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

CONSUMPTION.

In the following tables, showing the consumption of spelter in the United States and in the world for the period 1898–1912, the figures of foreign consumption are computed from statistics published by the Metallgesellschaft for 1912. In those statistics consumption is calculated on the basis of production, plus excess of imports over exports or minus excess of exports over imports, and altogether disregards smelter stocks. For the sake of comparison the consumption of the United States is calculated by both methods. Although in the long run the stocks carried over from one year are consumed in the next, and thus are equalized, it can not be gainsaid that for the individual year to take stocks into account gives greater accuracy. To obtain perfectly accurate figures of consumption it would be necessary to consider the stocks in the hands of consumers and dealers and to take into account the secondary spelter consumed.

Consumption of primary spelter in the United States, 1907–1912, in short tons.

	1907	1908	1909	1910	1911	1912
Supply:						
Stock Jan. 1—						
In bonded warehouses	.....	2	9	39	31	32
At smelters	3,824	26,364	19,613	11,167	23,201	9,049
Production	249,860	210,424	255,760	269,184	286,526	338,806
Imports	1,778	881	9,454	1,960	609	11,115
Total available	255,462	237,671	284,836	282,350	310,367	359,002
Withdrawn:						
Exports, foreign, from warehouse	9	8	334	4,758	11,276	6,286
Exports, foreign, under drawback	1,555	1,234	.....	4,486	3,079	1,219
Exports, domestic	563	2,640	2,566	3,990	6,872	6,634
Stock, Dec. 31—						
In bonded warehouses	2	9	39	31	32	48
At smelters	26,364	19,613	11,167	23,201	9,049	4,474
Total withdrawn	28,493	23,504	14,106	36,466	30,308	18,661
Apparent consumption	226,969	214,167	270,730	245,884	280,059	340,341

In considering the consumption of primary spelter there should be borne in mind the rapidly increasing quantity of secondary material, such as zinc skimmings, ashes, hard zinc, and scrap zinc, from which zinc is recovered in the form of spelter, alloy, pigment, chemical, etc., and so used again, thus affecting the consumption of primary spelter. The total quantity of secondary zinc recovered in 1912, so far as there is available record, was 94,111 tons, as compared with 74,747 tons in 1911. For details of the recovery of secondary zinc in 1912 and previous years see under the heading "Secondary zinc" in this chapter.

The consumption of spelter of foreign origin, both that made in this country from foreign ore and that imported directly as spelter, is a matter of much importance to American zinc producers and smelters. The following table gives this consumption of foreign spelter for the period from 1907 to date. A certain portion of the

stocks reported by the smelters as on hand at the close of the year must consist of spelter made from foreign ores, and this has not been taken into consideration in the table, but although this would affect the consumption for any single year it will not impair the usefulness of a table covering the length of time here given.

Foreign zinc consumed in United States, 1907–1912, in short tons.

	1907	1908	1909	1910	1911	1912
Supply:						
Produced from foreign ore	26,115	19,675	25,535	16,705	14,905	14,899
Stocks in bonded warehouse	.....	2	9	39	31	32
Imports	1,778	881	9,454	1,960	609	11,115
Total supply	27,893	20,558	34,998	18,704	15,545	26,046
Withdrawn:						
Exports from warehouse	9	8	334	4,758	11,276	6,286
Exports with drawback	1,555	1,234	.....	4,486	3,079	1,219
Stocks in warehouse	2	9	39	31	32	48
Total	1,566	1,251	373	9,275	14,387	7,553
Consumption of foreign zinc	26,327	19,307	34,625	9,429	1,158	18,493

World's consumption of spelter, by countries, 1907–1912, in short tons.

[Stocks disregarded except in the United States.]

	1907	1908	1909	1910	1911	1912
Austria-Hungary	34,171	35,925	36,155	37,258	47,950	51,698
Belgium	60,627	74,936	71,209	84,326	71,539	73,964
France	76,720	85,956	73,744	62,059	90,389	90,389
Germany	192,792	198,580	207,343	196,320	241,734	248,899
Great Britain	154,653	152,627	171,408	195,989	193,674	204,146
Holland	4,189	4,189	4,409	4,409	4,409	4,409
Italy	7,496	9,257	9,039	8,929	11,133	11,795
Russia	19,290	19,946	20,282	27,447	32,518	31,967
Spain	5,180	5,512	4,960	4,630	5,291	5,181
Other countries	13,228	11,020	9,921	13,668	19,621	21,715
United States	226,969	214,167	270,730	245,884	280,059	340,341
Total	795,315	812,115	879,200	880,919	998,317	1,084,504

World's consumption of spelter, exclusive of secondary zinc, 1898–1912, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States percentage.
1898	108,199	106,185	422,070	528,255	20.10
1899	124,585	123,688	422,181	545,869	22.66
1900	99,399	102,414	420,858	523,272	19.57
1901	141,697	137,789	424,496	562,285	24.51
1902	152,682	154,133	465,391	619,529	24.88
1903	154,381	157,900	480,162	638,062	24.75
1904	180,911	176,804	520,506	697,400	25.36
1905	200,438	198,835	534,285	733,120	27.13
1906	220,781	221,142	556,882	778,024	28.42
1907	226,969	249,511	568,346	817,857	30.51
1908	214,167	207,423	597,948	805,371	25.75
1909	270,730	262,314	608,472	870,784	30.12
1910	245,884	257,910	635,035	892,945	28.88
1911	280,059	265,908	718,258	984,166	27.02
1912	340,341	335,782	744,163	1,079,945	31.09

USES OF SPELTER.

Statistics of the use of spelter are not collected by the United States Geological Survey. The following table is from figures published in the Engineering and Mining Journal, which, though confessedly not complete, will nevertheless give an idea of the relative importance of the different uses of spelter for the period included. Figures since 1910 are not available.

Consumption of spelter in the United States, 1906–1910, by uses.

Use.	Percentage of total consumption.					
	1905	1906	1907	1908	1909	1910
Galvanizing	50.00	55.00	62.7	62.2	62.7	60.0
Brass making	26.00	25.25	18.4	17.2	18.3	20.0
Sheet zinc	17.00	16.00	12.4	14.1	12.6	11.0
Lead desilverization	1.25	1.00	1.1	1.3	1.0	.....
Other purposes	5.75	2.75	5.4	5.2	5.4	9.0
Total	100.00	100.00	100.0	100.0	100.0	100.

GRADES OF PRIMARY SPELTER.

The American Society for Testing Materials has adopted the following standard specifications for primary or virgin spelter:[1]

Under these specifications virgin spelter—that is, spelter made from ore or similar raw material by a process of reduction and distillation and not produced from reworked metal—is considered in four grades, as follows:

(*a*) High grade; (*b*) intermediate; (*c*) brass special; (*d*) prime western.

Marks: A brand shall be cast in each slab by which the maker and grade can be identified.

Lots: The maker shall use care to have each carload of as uniform a quality as possible.

COMPOSITION.

(*a*) High grade: The spelter must not contain over 0.07 per cent lead, 0.03 per cent iron, 0.05 per cent cadmium. It must be free from aluminum. The sum of the lead, iron, and cadmium must not exceed 0.1 per cent.

(*b*) Intermediate: The metal must not contain over 0.2 per cent lead, 0.03 per cent iron, 0.5 per cent cadmium. It must be free from aluminum. The sum of the lead, iron, and cadmium must not exceed 0.5 per cent.

(*c*) Brass special: The metal must not contain over 0.75 per cent lead, 0.04 per cent iron, 0.75 per cent cadmium. It must be free from aluminum. The sum of the lead, iron, and cadmium must not exceed 1.2 per cent.

(*d*) Prime western: Must not contain over 1.5 per cent lead, 0.08 per cent iron.

Physical: The slabs must be reasonably free from surface corrosion or adhering foreign matter.

Sampling: Not less than 10 slabs shall be taken as a sample from each car; for smaller lots in the same proportion to the total number, but in no case less than 3 slabs. In case of dispute half of the sample is to be taken by the maker and half by the purchaser; the whole to be mixed.

The slabs selected as samples are to be sawed completely across and the sawdust used as a sample. In case no saw is available for this purpose the slabs should be drilled completely through and the drillings cut up into short lengths. The saw or drill used must be thoroughly cleaned. No lubricant shall be used in either sawing or drilling, and the sawdust or drillings must be carefully treated with a magnet to remove any particles of iron derived from the tools.

[1] Metal Industry, July, 1911, p. 301.

PRICES AND VALUE.

PRICES.

Spelter opened at St. Louis in January at 6.25 cents a pound, which was the minimum price of the year. A gradual rise, broken by a sharp decline in March and another in July and August, carried the price to 7.5 cents, the highest price of the year in the latter part of September. The year closed with spelter at about 7 cents. The average St. Louis price of prime western spelter was 6.9 cents a pound, compared to 5.7 cents a pound in 1911. The average price of spelter at New York in 1912 was 7.1 cents, as compared with 5.8 cents in 1911. The average price of spelter at St. Louis is used by the United States Geological Survey in calculating the value of the domestic production of spelter.

In London spelter opened at £26 15s. a long ton (5.78 cents a pound), less than half a cent below the St. Louis price. It reached the minimum of the year late in March, at £25 a long ton (5.4 cents a pound), and gradually rose to the highest point of the year in October, at £27 12s. 6d. a long ton (5.98 cents a pound). After a gradual decline, spelter closed at about £26 10s. a long ton (5.73 cents a pound). The average price for the year was £26 8s. 7d. a long ton (5.7 cents a pound).

For the last four months of the year the average St. Louis price of spelter was more than 1½ cents above the London price. It was during this period that the larger part of the 11,115 tons of foreign spelter was imported.

The price of zinc dust through the first half of 1912 varied from $7\frac{1}{16}$ to $7\frac{1}{2}$ cents per pound. From July to September it varied from $7\frac{3}{8}$ to $7\frac{3}{4}$ cents per pound, remaining at this latter figure until the end of November and closing the year at $7\frac{5}{8}$ cents per pound.

The price of zinc dust in Germany at the beginning of the year was 53 marks per 100 kilograms (5.7 cents per pound) f. o. b. Stettin. With increasing demand the price gradually rose until in November it reached 56 marks (6 cents per pound), after which a decline closed the year with zinc dust at 54.75 marks (5.9 cents per pound).

The following table, giving highest and lowest prices of spelter in each month for the years 1902–1912, inclusive, is based on figures in the Iron Age prior to 1906. For 1906 and later the figures are based on the daily quotations in the Engineering and Mining Journal. Prior to 1909 the quotations are from New York City, but for 1909 and after St. Louis prices are taken.

Monthly price range of prime western spelter, 1902–1912.

[Cents per pound.]

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.30	4.25	4.25	4.00	4.35	4.20	4.45	4.40
1903	4.90	4.55	5.05	4.97	5.75	5.05	5.75	5.50
1904	5.10	4.90	5.10	4.95	5.20	5.05	5.27	5.20
1905	6.20	6.10	6.15	6.10	6.15	5.87	6.00	5.75
1906	6.70	6.00	6.15	6.05	6.35	6.10	6.15	6.05
1907	6.80	6.70	6.90	6.70	6.90	6.75	6.80	6.55
1908	4.60	4.25	4.85	4.55	4.80	4.60	4.70	4.60
1909	5.20	5.075	5.075	4.525	4.625	4.55	4.95	4.60
1910	6.075	5.65	5.70	5.25	5.625	5.45	5.475	4.90
1911	5.425	5.275	5.55	5.25	5.525	5.30	5.325	5.25
1912	6.50	6.25	6.70	6.40	6.90	6.55	6.75	6.60

Monthly price range of prime western spelter, 1902–1912—Continued.

[Cents per pound.]

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.65	4.40	4.85	4.80	5.35	5.05	5.50	5.35
1903	5.80	5.75	6.25	5.75	6.25	5.87	6.00	5.80
1904	5.22	4.95	4.95	4.75	4.90	4.87	5.07	4.90
1905	5.70	5.40	5.35	5.25	5.60	5.25	5.80	5.60
1906	6.10	5.90	6.20	6.00	6.05	5.97	6.05	6.02
1907	6.60	6.35	6.45	6.35	6.35	5.85	5.90	5.50
1908	4.675	4.55	4.675	4.45	4.70	4.40	4.775	4.65
1909	5.125	4.875	5.325	5.10	5.325	5.175	5.675	5.325
1910	5.175	4.85	5.075	4.925	5.075	4.95	5.275	5.00
1911	5.25	5.20	5.65	5.20	5.70	5.525	6.05	5.675
1912	6.80	6.65	7.00	6.75	7.10	6.95	7.20	6.80

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	5.50	5.30	5.50	5.40	5.35	5.10	5.00	4.50
1903	6.10	6.00	6.12	6.00	6.00	5.25	5.25	4.65
1904	5.15	5.07	5.37	5.15	5.80	5.37	6.12	5.80
1905	5.95	5.75	6.15	6.00	6.25	6.10	6.60	6.40
1906	6.35	6.05	6.30	6.15	6.45	6.25	6.65	6.45
1907	5.50	5.05	5.55	5.25	5.25	4.50	4.55	4.10
1908	4.825	4.70	4.875	4.75	5.05	4.875	5.15	5.10
1909	5.80	5.55	6.275	5.775	6.275	6.175	6.225	6.00
1910	5.45	5.225	5.725	5.375	5.90	5.70	5.775	5.275
1911	5.95	5.80	6.25	5.825	6.85	6.25	6.80	6.10
1912	7.50	7.20	7.45	7.30	7.375	7.25	7.25	7.15

VALUE.

The production of primary spelter from domestic ores in 1912 was 323,907 short tons, valued at $44,699,166, based on the average St. Louis price, as compared with 271,621 short tons, valued at $30,964,794, based on the average St. Louis price in 1911, a gain of 52,286 tons, equal to 19.2 per cent in quantity, and of $13,734,372, equal to 44.4 per cent in value. The production in 1910 was 252,479 tons, valued at $27,267,732, and in 1909 it was 230,255 tons, valued at $24,864,300.

PRICE CURVES, 1911–12.

The following curves show graphically for the years 1911–12, inclusive, the relations of the weekly average St. Louis price of spelter, the weekly average London price of spelter, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and the weekly production, or, to be more exact, the weekly sales of concentrates in the Joplin region as a whole. The price of spelter has been taken from market reports, and the price of zinc blende and the figures of weekly production are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken line.

The curve of London price of spelter shows the stabilizing effect of the Zinc Convention. The St. Louis price of spelter shows a minor dependence upon the English market, but a major independence of

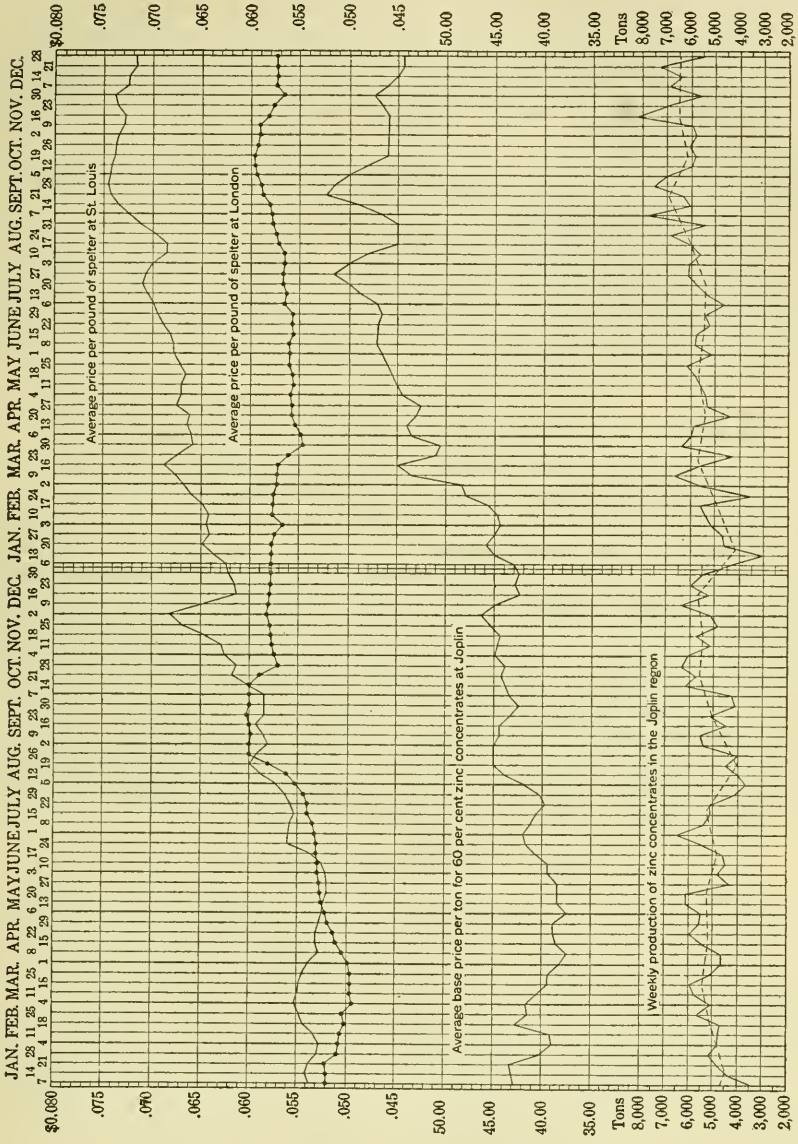

FIGURE 7.—Average weekly price of spelter at London and St. Louis, of 60 per cent zinc concentrates at Joplin, and weekly production (sales) of zinc concentrates in the Joplin region in 1911–12.

it. On the whole the price of zinc concentrates at Joplin shows a close correspondence to the price of spelter at St. Louis, though there are various minor discrepancies.

THE JOPLIN ORE SCALE.

Upon the organization of the Zinc Ore Producers' Association at Joplin, early in 1910, that body undertook to ascertain the best methods of marketing Joplin ore. The central selling agency and the sliding-scale contract were among the plans suggested. The ore scale was finally adopted, and by the close of the year about a fifth of the tonnage of the district had been contracted for under the uniform terms of the scale. That part of the contract governing prices is as follows:

Spelter quotation governing to be the average of the American Metal Market and Daily Iron Trade Reports, direct St. Louis wire, for the week preceding the delivery of such concentrates .

For concentrates, except sludges, carrying 60 units zinc, the sum of $37 per ton (2,000 pounds dry weight), when spelter is quoted at $5 per hundredweight, East St. Louis delivery.

Unit variation, $1 per ton for each unit above or below 60 per cent.

Price variation, 8.5 cents per ton up or down for each change of 1 cent per 100 pounds spelter.

Premium of $1 per ton for concentrates carrying one-half of 1 per cent lead or less.

Iron allowance: Two per cent, no penalty; above 2 per cent to and including 5 per cent, $1 per ton per unit penalty; above 5 per cent, 50 cents per unit.

On a declining market the ore contract naturally worked to the advantage of the producer, seeing that the selling price of ore was based on the average price of spelter for the preceding week. On a rising market, however, the plan worked to the detriment of the producer. For a short time after the signing up of the scale the market declined and the contract price was satisfactory. During the latter part of the year, however, the continued rise in the price of spelter resulted in a weekly loss of those selling on contract and, furthermore, the lower price paid for the contract ore was thought to have a tendency to hold down offerings in the open market. The result was dissatisfaction with the ore scale, which became so great that on the expiration of the contracts at the close of the year very few were renewed. However, some ore continues to be sold on contract, in particular some ore from Miami, Okla.

THE ZINC CONVENTION.

The Zinc Convention was formed early in 1909, to remain in force until the close of 1910. It comprised the Zinkhüttenverband m. b. H. and the Société Anonyme des Mines et Fonderies de la Vieille Montagne. The former association embraces 18 zinc smelting firms in Silesia, the Rhine district, Belgium, and Austria. One large firm, Georg von Giesche's Heirs, did not join the association, but acted in concert. The Société Anonyme includes 10 smelters, the majority located in Belgium. The more important English smelters joined the convention late in 1909. The purpose of the convention was to fix beforehand, within certain limits, the production of spelter by its members, and, if the market gave evidence that the consumption was not keeping pace with the production, further to curtail production. The output of the German group was limited to 255,700 metric tons in 1909 and to 264,200 metric tons in 1910, and the output of the Franco-Belgian group was not to exceed 174,500 metric tons in 1909 and 176,900 metric tons in 1910.

The output of the Engilsh smelters under the terms of the agreement was to be approximately 55,000 metric tons annually. If the average price of ordinary brands of spelter remained below £19 per long ton (4.11 cents per pound) for six consecutive months, a pro rata reduction of the fixed output was to be made.

At the close of 1910 the Zinc Convention had, on the whole, worked so well that it was extended until April 30, 1914. Certain features which had aroused antagonism (notably the restriction clause) were modified in the new terms. Under the new agreement there will be no restriction of output so long as the total stocks of spelter, ascertained every quarter, do not exceed 50,000 metric tons and so long as the London price of spelter does not fall below £22 per long ton (4.8 cents per pound). Should this contingency arise, production is to be restricted pro rata on the basis of each smelter's output during the last quarter. The outstanding smelting firm, Georg von Giesche's Heirs, will sell its ouput through the association agencies and has agreed to the limitation clause, though it does not regularly become a member.

SUMMARY.

Summary of spelter statistics for 1907–1912.

	1907	1908	1909	1910	1911	1912
Production of spelter by United States	249,860	210,424	255,760	269,184	286,526	338,806
Consumption of spelter by United States (stocks considered)	226,969	214,167	270,730	245,884	280,059	340,341
Production of spelter by world	813,830	796,896	854,066	893,046	986,061	1,070,045
Consumption of spelter by world (stocks considered in United States)	795,315	812,115	879,200	880,919	998,317	1,084,504
Excess of world production over consumption	18,515	.....	.....	12,127	.....	.....
Excess of world consumption over production	.....	15,219	25,134	.....	12,256	14,490
United States percentage of world production	30.7	26.4	29.9	30.1	29.1	31.7
United States percentage of world consumption (stocks considered in United States)	28.5	26.4	30.8	27.9	29.1	31.4
Rank of United States in spelter production	First.	Second.	First.	First.	First.	First.
Rank of United States in spelter consumption	First.	First.	First.	First.	First.	First.

SURVEY PUBLICATIONS ON LEAD AND ZINC.

The following list includes the more important publications on lead and zinc published by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The publications marked "exhausted" are no longer available for distribution but may be seen at the larger libraries of the country.

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BAIN, H. F., VAN HISE, C. R., and ADAMS, G. I., preliminary report on the lead and zinc deposits of the Ozark region: Twenty-second Ann. Rept., pt. 2, 1902, pp. 23–228. $2.25.

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ELLIS, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, 1905, pp. 311–315. Exhausted.

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PRECIOUS AND SEMIPRECIOUS METALS IN THE EASTERN STATES IN 1912.

(MINE PRODUCTION.)

By H. D. McCaskey.

INTRODUCTION.

In the following pages is given a brief review of the gold, silver, copper, lead, and zinc production and mining industries in the Eastern or Appalachian States for the calendar year 1912. The area covered is for the greater part coincident with the broad belt of old metamorphic and associated igneous rocks extending southwestward from Canada to Alabama. The zinc-lead belt of southwestern Virginia and eastern Tennessee, however, whose rocks are mainly Cambrian and Ordovician limestone and dolomite, lies to the west of this great metamorphic belt.

References have been given in previous reports to the most important papers on these mines in the Eastern States, and the geologic relations were briefly described. At the end of this report are given lists of the most important Survey publications on the precious and semiprecious metals of the Eastern or Appalachian States.

PRODUCTION.

The total value of the mine output of gold, silver, copper, lead, and zinc in the Eastern or Appalachian States in 1912 was $13,470,276, against a corresponding value of $11,787,942 in 1911, an increase for 1912 of $1,682,334.

The following table shows concisely the production of ore and precious and semiprecious metals of the Eastern or Appalachian States from 1906 to 1912, inclusive:

Tonnage of ore treated and mine production of metals in the Appalachian States, 1906–1912.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1906	979,881	$236,731	89,088	18,849,605	9,750	141,282,000	$12,572,454
1907	906,103	239,902	85,661	20,307,180	140,599	119,176,000	11,396,153
1908	1,116,392	259,143	66,170	19,880,894	76,190	136,429,800	9,333,902
1909	1,322,849	155,940	66,912	20,354,225	.....	166,328,859	11,818,531
1910	1,252,231	185,522	91,595	17,923,412	198,850	140,875,886	10,127,304
1911	1,258,144	159,370	108,105	19,605,386	834,742	159,351,558	11,787,942
1912	1,361,734	222,496	96,523	19,265,945	561,026	144,699,863	13,470,276
Increase (+) or decrease (—) in 1912	+103,590	+63,126	—11,582	—339,441	—273,516	—14,651,695	+1,682,334

GOLD.

The total gold production was 10,763.24 fine ounces, valued at $222,496, an increase of 3,053.72 fine ounces in quantity and of $63,126 in value for 1912. The placers yielded 774.83 fine ounces, the siliceous or gold-quartz ores 9,302.99 ounces, the copper ores 443.50 ounces, and the lead and lead-zinc ores 241.92 ounces of gold. The only State increase in gold production was the notable one of $95,232 in North Carolina. In all the remaining States the gold output declined in 1912, the decrease being $20,710 in Georgia, and from $2,000 to $3,500 each in Alabama, South Carolina, Tennessee, and Virginia.

SILVER.

The production of silver in the Eastern States in 1912 was 96,523 fine ounces, valued at $59,361,[1] a decrease from the output for 1911 of 11,582 fine ounces, but an increase of $2,065 in value. The silver yield is recovered entirely from the refining of the gold, lead, and copper produced, and the bulk of it is from the copper ores of the Ducktown district, Tenn., where there was a decrease of 16,767 ounces in 1912. The output from gold-quartz and lead-zinc ores of North Carolina, however, showed an increase of nearly 4,000 ounces in 1912. The changes in yield in the remaining Eastern States were insignificant.

Mine production of gold and silver in Eastern States in 1912, by States, in fine ounces.

State.	Gold.		Silver.		Increase (+) or decrease (−) in value compared with 1911.	
	Quantity.	Value.	Quantity.	Value.	Gold.	Silver.
Alabama	809.02	$16,724	168	$103	− $2,192	+ $12
Georgia	694.67	14,360	77	47	− 20,710	− 65
Maryland and Pennsylvania			502	309	− 9	+ 263
North Carolina	8,030.93	166,014	4,854	2,985	+ 95,732	+ 2,485
South Carolina	818.26	16,915	47	29	− 3,493	+ 23
Tennessee	399.82	8,265	89,893	55,284	− 3,356	− 1,246
Virginia	10.54	218	982	604	− 2,846	+ 593
Total	10,763.24	222,496	96,523	59,361		
Increase (+) or decrease (−) in 1912.	+ 3,053.72	+ 63,126	− 11,582	+ 2,065	+ 63,126	+ 2,065

Source of gold and silver in Eastern States in 1912, by States, in fine ounces.

State.	Gold.				Silver.			
	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.
Alabama		809.02				168		
Georgia	331.18	363.49			23	54		
Maryland and Pennsylvania							502	
North Carolina	423.38	7,321.95	43.86	241.92	35	1,902	523	2,394
South Carolina	20.27	797.99				47		
Tennessee			399.82				89,893	
Virginia		10.54					982	
Total	774.83	9,302.99	443.50	241.92	58	2,171	91,900	2,394

[1] The average New York commercial price of silver per fine ounce in 1912 was 61½ cents.

COPPER.

The copper output of the Eastern States from copper and iron ores and, to a smaller extent, from mixed ores and mine waters, was 19,265,945 pounds, valued at $3,178,882 [1] in 1912, against a production of 19,605,386 pounds, valued at $2,450,674 in 1911, a decrease of 339,441 pounds in quantity but an increase of $728,208 in value. The great bulk of the production was, as usual, from the well-known Ducktown district of eastern Tennessee, the remainder coming from Pennsylvania, North Carolina, Virginia, and Maryland.

LEAD.

The production of lead in the Eastern States in 1912 was 561,026 pounds, valued at $25,246,[2] a decrease of 273,746 pounds in quantity and of $12,317 in value from the yield for 1911. The production was chiefly from southwest Virginia, as usual, but 92,000 pounds was also produced in North Carolina in 1912.

ZINC.

The zinc output of the Eastern States in 1912, figured as spelter was 144,699,863 pounds, valued at $9,984,291.[3] These figures show a decrease of 14,651,695 pounds of zinc, but an increase of $901,252 in value of output, as compared with the production of 1911. The zinc production was mainly from New Jersey, as it has been for many years, but there was a large production also from Tennessee, where the output doubled in 1912, and there were considerable yields from Virginia and North Carolina.

Mine production of copper, lead, and zinc in Eastern States in 1912, by States, in pounds

State.	Copper.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Maryland and Pennsylvania	594,022	$98,014	.....	.....	.....	.....
New Jersey	.....	.....	.....	.....	139,510,008	$9,626,191
New York	.....	.....	.....	.....	28,000	1,932
North Carolina	75,915	12,526	92,000	$4,140	283,320	19,549
Tennessee	18,483,173	3,049,724	.....	.....	4,381,300	302,310
Virginia	112,835	18,618	469,026	21,106	497,235	34,309
Total	19,265,945	3,178,882	561,026	25,246	144,699,863	9,984,291
Increase (+) or decrease (−) in 1912	−339,441	+728,208	−273,716	−12,317	−14,651,695	+901,252

NUMBER OF MINES AND ORE OUTPUT.

There were 93 producing mines in 1912, of which 43 were deep mines and 50 were placers—most of them small. In 1911 there were 96 mines, of which 57 were placers. Of the 43 producing deep mines in 1912, the gold mines numbered 28, the copper mines 8, and the zinc (and lead-zinc) mines 7. The largest number of operating

[1] The Survey figure for the average price of copper in 1912 is 16½ cents a pound.
[2] The Survey figure for the average price of lead in 1912 is 4½ cents a pound.
[3] The Survey figure for the average price of spelter in 1912 is 6⁹⁄₁₀ cents a pound

mines in 1912 was in North Carolina, where there were 36, of which 22 were placers, 1 a copper mine, 1 a lead-zinc mine, and the remainder gold-quartz mines. In Georgia there were 28 producers, of which 23 were gold placers and the remainder gold-quartz mines. In South Carolina there were in all 5 placers and 7 gold-quartz mines. In Virginia copper was produced from 2 pyrite mines, lead and zinc from 3 lead-zinc mines, and gold from only 1 property. In Alabama were 3 producing gold-quartz mines; in Maryland and Pennsylvania combined 3 mines producing copper; in Tennessee 2 copper mines and 1 zinc producer; and in New Jersey and New York 1 producing zinc mine each.

The total tonnage of ore sold or treated in 1912 was 1,361,734 short tons, of which 33,813 tons were gold-quartz ores, 830,089 tons were copper and copper-bearing iron pyrite and oxide ores, and 497,832 tons were zinc and lead-zinc ores. The gold-quartz ores were mainly from North Carolina and South Carolina, with Alabama third in output, and nearly three-fourths of the copper ores were from the Ducktown district of Tennessee, the remainder being mainly the copper-bearing magnetites of the Cornwall mines of Pennsylvania. The zinc ores were chiefly from New Jersey, with smaller quantities from Tennessee, Virginia, and North Carolina in the order named. The lead-zinc ores were from Virginia and North Carolina.

The gold-quartz ores yielded an average recovery per ton of $5.73 in precious metals in 1912. The copper ores averaged a recovery of $0.08 in gold and silver and 23.1 pounds of copper per ton; the lead-zinc ores yielded an average recovery of $5.33 in gold and silver and 139.6 pounds of lead per ton; and the zinc ores yielded no precious metals, but an average recovery of 290.7 pounds of zinc per ton.

Total number of producing mines, ore production, and average value of gold and silver per ton in Eastern States in 1912, by States, in short tons.

State.	Number of mines.			Ore production from deep mines and average recovered value in gold and silver per short ton mined.							
				Total production.	Dry or siliceous ores.		Copper ores.		Lead ores.		Zinc ores.[a]	
	Placer.	Deep.	Total.		Quantity	Average value.	Quantity.	Average value.	Quantity.	Average value.	Quantity.	Average value.
Alabama	....	3	3	5,693	5,693	$2.96	.....	.....	.....	.....	.....	.....
Georgia	23	5	28	1,359	1,359	5.53	.....	.....	.....	.....	.....	.....
Maryland and Pennsylvania	....	3	3	225,200	.....	.....	225,200	$0.0014	.....	.....	.....	.....
New Jersey	....	1	1	459,585	.....	.....	.....	.....	.....	.....	459,585	.....
New York	....	1	1	100	.....	.....	.....	.....	.....	.....	100	.....
North Carolina	22	14	36	16,073	14,358	10.62	500	2.25	(b)	$5.33	c 1,215	.....
South Carolina	5	7	12	12,358	12,358	1.34	.....	.....	.....	.....	.....	.....
Tennessee	....	3	3	635,576	.....	.....	603,229	.105	.....	.....	32,347	.....
Virginia	....	6	6	5,790	45	2.98	1,160	.52	.....	.....	c 4,585	.....
Total	50	43	93	1,361,734	33,813	5.73	830,089	.08	.....	5.33	497,832	.....

[a] No recovery of gold or silver from zinc ores.
[b] The lead concentrates of lead-zinc ores yielded $51.28 in gold and silver per ton of concentrates; no recovery from the zinc concentrates.
[c] Includes lead-zinc ore.

Number of copper, lead, and zinc producing mines, ore tonnage, and average pounds of metal recovered per short ton of ore in Eastern States in 1912, by States.

State.	Number of mines.		Copper ore.		Lead ore.		Zinc ore.	
	Copper.	Zinc.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.
Maryland and Pennsylvania.	3	.....	225,200	2.64	.....	.....	.....	.....
New Jersey.....	.....	1	.....	.....	.....	.....	459,585	303.5
New York.....	.....	1	.....	.....	.....	.....	100	280.0
North Carolina.....	1	[a] 1	500	151.8	Lead-zinc ore.	75.7	1,215	233.2
Tennessee.....	2	1	603,229	30.6	.....	.....	32,347	135.4
Virginia.....	[b] 2	[a] 3	1,160	19.7	.....	167.3	[c] 4,585	108.4
Total.....	8	7	830,089	23.1	.....	139.6	497,832	290.7

[a] Includes lead and zinc mines. [b] Part of copper from mine water. [c] Includes lead-zinc ores.

PRECIOUS AND SEMIPRECIOUS METAL INDUSTRY IN THE EASTERN STATES.

A study of the statistics of production of precious and semiprecious metals in the Eastern States shows comparatively small fluctuations in total mining activities and outputs for a series of years. The few larger gold mines of the Carolinas, of Alabama, and until recently of Georgia, have been operating more or less continuously and have produced the bulk of the gold output. These mines will probably continue a steady production, though some have already closed down and others have shown falling off in production. The small placers, especially in Georgia and North Carolina, represent a nominal but continuous production of gold also. The lands in the South are mainly agricultural, and farming is done on the surface of many of the gold properties. Apparently the placer output is now steadily on the decline and the operations are mainly intermittent and incidental. The copper production is chiefly from two large mines with steady output in Tennessee, and the zinc production is chiefly from a single famous producer of New Jersey. In Virginia, however, there continues annually a production of lead and zinc from the old Wythe County mines and of copper as a by-product of the pyrite mines. The lead production in the East has been relatively insignificant of recent years.

Changes for 1912 in Appalachian precious and semiprecious metal mining were therefore unimportant. Placer gold output in general showed a marked falling off, and gold mining in Georgia and Virginia reached the lowest ebb in many years; but the Iola mine and mining generally in North Carolina showed an increase in production. The number of zinc producers in Tennessee declined, but the production was doubled in that State. The total copper output showed little change, though the market value of the production materially increased.

REVIEW BY STATES.

ALABAMA.

The mine production of gold in Alabama in 1912 was 809.02 fine ounces, valued at $16,724, and of silver, 168 fine ounces, valued at $103, against 915.06 fine ounces of gold, valued at $18,916, and 171

fine ounces of silver, valued at $91, in 1911. The gold output was all from gold-quartz mines in 1912 and the silver production was entirely from refining the gold bullion produced. No copper, lead, or zinc output was reported from Alabama in either 1912 or 1911.

The following table shows the mine production of gold, silver, and copper in Alabama since 1905, when the United States Geological Survey first collected detailed figures from the mines of the Eastern States:

Tonnage of ore treated and output of metals in Alabama, 1905–1912.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	
1905	16,425	$41,530	336	.....	$41,733
1906	8,565	24,921	124	.....	25,004
1907	18,400	25,982	439	84,678	43,208
1908	11,174	41,208	282	.....	41,357
1909	9,886	29,239	212	.....	29,349
1910	9,763	33,533	268	.....	33,678
1911	6,360	18,916	171	.....	19,007
1912	5,693	16,724	168	.....	16,827
Decrease in 1912	667	2,192	3	.....	2,180

[a] Includes placer gold and silver.

The production for 1912 was from 5,693 short tons of siliceous ore, with an average recoverable precious metal value of $2.96 per ton, against 6,360 tons and a recovery of $2.99 in 1911 and 9,763 tons and a recovery of $3.41 in 1910.

In Clay County, near Pyriton, are several pyrite mines, all idle in 1912, whose ores were formerly sold for their sulphur content and produced residues containing gold, silver, and copper. No operations were reported from the Gold Ridge properties in Cleburne and Randolph counties, although the last-named prospects were leased and may be operated in 1913. The equipment includes a 20-stamp mill and an 80-ton cyanide plant. At the Storey prospect in Talladega County a small tonnage was again treated during operations of about two months of the 5-stamp amalgamation mill. The Tallapoosa mine, of Tallapoosa County, was also operated a short time in 1912, and produced gold on a small scale. The output was again chiefly from the Hog Mountain, or Hillabee, mines in Tallapoosa County, operated in 1912 under lease. The ores treated in 1912 were oxidized, and were all cyanided in the 75-ton plant of the company.

GEORGIA.

The production of gold in Georgia in 1912 was 694.67 fine ounces, valued at $14,360, and that of silver was 212 fine ounces, valued at $112, a total value of $14,407 for 1912 and a decrease from the production of 1911 of $20,710 in value of gold and of $20,775 in total value. No production of copper, lead, or zinc was reported from Georgia in 1912.

The following table shows the production for the years 1905 to 1912, inclusive:

Tonnage of ore treated and mine production of metals in Georgia, 1905–1912.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	16,000	$96,910	1,040	8,841	19,394	$103,400
1906	2,150	31,050	599	26,198	9,750	37,065
1907	4,727	64,808	864	22,800	14,400	70,701
1908	6,196	56,207	200	.....	.....	56,313
1909	8,549	60,620	202	.....	.....	60,725
1910	13,562	35,602	335	.....	.....	35,783
1911	3,737	35,070	212	.....	.....	35,182
1912	1,359	14,360	77	.....	.....	14,407
Decrease in 1912	2,378	20,710	135	.....	.....	20,775

[a] Includes placer gold and silver.

There were 23 placers and 5 deep mines reported as producing gold and silver in Georgia in 1912 against 24 placers and 7 deep mines in 1911. From the placers were produced 331.18 fine ounces of gold and 23 ounces of silver in 1912, and from the deep mines, all gold-quartz properties, the yield was 363.49 ounces of gold and 54 ounces of silver. The deep mines produced 1,359 short tons of siliceous gold ores in 1912, yielding an average recovery of $5.53 in gold and silver per ton, against 3,737 tons in 1911 with an average recovered value of $3.05 per ton.

The following table shows the production of gold and silver in Georgia by counties in 1912:

Mine production of gold and silver in Georgia, 1912, by counties, in fine ounces.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
Carroll, Douglas, and Paulding	43.20	$893	.....	.....	$893
Cherokee	26.17	541	5	$3	544
Dawson and Haralson	148.22	3,064	24	15	3,079
Fulton and Lincoln	9.29	192	.....	.....	192
Lumpkin	263.36	5,444	19	11	5,455
Milton, McDuffie, and Oglethorpe	119.15	2,463	13	8	2,471
White	85.28	1,763	16	10	1,773
Total, 1912	694.67	14,360	77	47	14,407
Total, 1911	1,696.51	35,070	212	112	35,182

Carroll County.—There was a nominal output of gold from the Watkins placer, near Villa Rica, in Carroll County, in 1912, by ground sluicing, and from other small operations. Near Villa Rica, also, are pyrite mines, from which there is an annual production of pyrite ore for the manufacture of sulphuric acid. Residues from the treatment of pyrite from the Appalachian States frequently contain copper, silver, and gold in the cinder, but the average content of these metals per ton of crude pyrite is usually small.

Cherokee County.—The production of Cherokee County in 1912 was 26.17 fine ounces of gold, valued at $541, and 5 fine ounces of silver, valued at $3, a total value of $544, against a gold output valued at $1,715 and a total value of $1,720 in 1911. The yield from this county has thus become almost insignificant since the closing down of the famous Franklin mine in 1909. The Etowah Dredging Co., organized a few

years ago to operate a small dredge on the Etowah near Canton, has gone into receiver's hands and the property has been disposed of. Nominal outputs of placer gold were reported from the old Sixes and other mines. At the Worley a new mill was erected with the expectation of production in 1913.

Dawson County.—A small production of placer gold was reported for 1912 from Dawson County. The Taylor Creek placer made a nominal output from hydraulic workings.

Douglas County.—The Pine Mountain property, 4 miles from Villa Rica, made a nominal output. The ore is reported to be oxidized gold quartz in altered slates and schists. The property changed ownership in June and was idle most of the year.

Haralson County.—At the Royal mine, near Tallapoosa, in Haralson County, a new cyanide plant was in course of erection in 1912, but there was no operation of the property during the year. The ore deposit lies apparently in the gold belt extending southwest into Cleburne and Randolph counties, Ala.

Lumpkin County.—The production of Lumpkin County in 1912 was 263.36 fine ounces of gold, valued at $5,444, and 19 fine ounces of silver, valued at $11, a total value of $5,455, against a production of $11,461 in gold in 1911 and 50 ounces of silver, valued at $26. Lumpkin and Cherokee counties, long the largest producers of gold in Georgia, have greatly decreased their yield in recent years. In Lumpkin County, especially, the Dahlonega and Auraria districts were notable producers in the past. In these districts there are still a considerable number of small placers, and operations still continue on a reduced scale at some of the old gold-quartz mines. Among the producers in 1912 were the Briar Patch and the Calhoun placers and the New Findley deep mine. The last is equipped with a 10-stamp amalgamation mill, and increased production was in prospect for 1913. The Bunker Hill Bucyrus dredge, with 3½-foot buckets, was operated for about 3 months on old ground with the object of reaching new territory on Chestatee River south of Dahlonega. The Water Power Mining Co. devoted its power to municipal lighting, but was also reported to have carried on some prospecting with a view to active operations in 1913.

McDuffie County.—In McDuffie County the Tatham and the Hamilton mines were not operated in 1912, but the Columbia mines produced gold and silver from siliceous sulphide ore treated in a 10-stamp amalgamation mill. Iron sulphide auriferous concentrates are saved by Wilfley tables and usually contain small quantities of lead and copper sulphides. No concentrates were shipped to smelters in 1912. The shaft is 450 feet deep, but no new sinking or drifting was done in 1912, the mine operations being limited to sampling. The mill capacity is in prospect of being increased. A new shaft was begun on the Parks mine at the close of the year.

Milton County.—There was a nominal output of placer gold by sluicing near Sheltonville in Milton County in 1912.

Paulding County.—A small output of placer gold was reported from Paulding County from gravel treated in ground sluices and Georgia rockers in the streams near Villa Rica.

Union County.—The Coosa Gold Mining Co. was reported engaged in prospecting near Blairsville in Union County in 1912, and work was done in open cuts, drifts, and inclines upon its property.

White County.—The gold output of White County was 85.28 fine ounces, valued at $1,763 in 1912, against 587.81 fine ounces, valued at $12,151, in 1911. The Loud placer mines, worked by hydraulicking, were again the main producers.

MAINE.

The Blue Hill mine, an old producer, was reported idle in 1912 for lack of capital. The property is on the seaboard and the ore is reported to contain 4.2 per cent of copper and $1.25 in precious metals per ton.

MARYLAND.

A small but increased output of concentrates, carrying copper and silver, was made again in 1912 from the New London mine in Frederick County. The mine is equipped with a 100-ton concentrating plant, including Hardinge pebble mill, trommel, and slime tables. Some years ago there was a small annual output of gold from Montgomery County, but there has been none reported since 1905.

The production of Maryland from 1905 to 1912, inclusive, was 14,458 short tons of ore, from which were produced $14,830 in gold, 682 fine ounces of silver, and 160,831 pounds of copper, with a total value of $41,336.

MASSACHUSETTS.

At the Essex lead-silver property, near Newbury, a small quantity of ore was mined in 1912. An expermiental concentrating plant was in prospect. At the Davis pyrite mine (which has produced copper as a by-product), near Charlemont, the old machinery has been discarded and new electrical equipment was in prospect. There were no shipments in 1912, but a new pyrite lens was to be developed in 1913.

NEW HAMPSHIRE.

The West Ossipee property, near the town of that name in Carroll County, was idle in 1912, but was reported in prospect of operation for 1913. The Mascot, the Mount Hayes, and the Milan properties, in Coos County, and the Warren zinc prospect in Grafton County, were also all idle in 1912.

There has been no metal production reported from New Hampshire for 1905, 1906, 1911, or 1912. For the four years 1907 to 1910, inclusive, the output was 6,095 short tons of ore, yielding $6,030 in gold, 10,370 fine ounces of silver, 274,540 pounds of copper, and 7,799 pounds of lead, with a total value of $47,962.

NEW JERSEY.

There was no output from any of the various old copper mines of New Jersey in 1912. At the Pahaquarry property, near Drumfield, in Warren County, a large plant for roasting and leaching the low-grade copper ores was reported completed in 1912.

The Franklin Furnace zinc mines continued their large output of zinc ore, producing an increased tonnage for 1912. The concentrating mills treated 363,588 short tons of crude ore, producing 298,901 short tons of concentrates. In addition 95,997 short tons

of crude ore were shipped. The total crude tonnage sold or treated was therefore 459,585 short tons, against 374,064 tons in 1911. The total recoverable zinc output in 1912 (figured as spelter), was 139,510,008 pounds, against 154,890,900 pounds in 1911.

The following table shows the zinc production of New Jersey for the years 1905 to 1912, inclusive:

Tonnage of ore treated and mine production of zinc in New Jersey, 1905–1912.

Year.	Ore sold or treated.	Zinc.	Total value.
	Short tons.	*Pounds.*	
1905	323,062	[a] 126,318,000	$7,452,762
1906	360,330	[a] 141,282,000	8,618,202
1907	329,205	[a] 119,176,000	7,031,384
1908	356,457	134,330,690	6,313,542
1909	475,838	165,020,071	8,911,084
1910	375,677	137,355,219	7,417,182
1911	374,064	154,890,900	8,828,781
1912	459,585	139,510,008	9,626,191
Increase (+) or decrease (−) 1912	+85,521	−15,380,892	+797,410

[a] Estimate based on ore tonnage given by H. B. Kümmel, State geologist, and average per cent of zinc in ore.

NEW YORK.

No further work was reported for 1912 from the various experimental operations attempting to recover gold from the sands of Adirondack streams. There has been no output of gold reported to date from this source and the results of experiments appear to have discouraged further operations.

In St. Lawrence County prospecting only was done at the Balmat zinc property near Edwards. At the Edwards zinc and pyrite mine, however, there was considerable sinking and other development and also experimental work in the 50-ton mill in magnetic separation of zinc blende from pyrite. It was found that dry separation was unsatisfactory, and a wet magnetic process was being developed in 1912. Shipments were made of zinc concentrates resulting from this experimental work. The ore deposits and mill work appear to promise interesting development on a commercial scale.

The production from 683 short tons of lead and zinc ores in 1911 was 4,200 pounds of lead and 161,840 pounds of zinc, with a total value of $9,414. In 1912 an estimated tonnage of 100 tons of ore produced 28,000 pounds of zinc, with a value of $1,932.

According to Newland[1] there were 8,000 tons of milling ore on the surface at the Edwards mine in 1911 and a larger quantity blocked out underground, and about one-third of the ore developed would bear shipment in crude state. To the 100-foot level the inclined shaft showed a continuous ore body in 1911, from 4 to 7 feet thick. The ore lens is reported to be blende and pyrite with little gangue, the richer material showing 40 to 50 per cent of zinc. The ores are found along a well-marked zone parallel to the talc deposits of this region and included with them in the crystalline limestones of the pre-Cambrian Grenville series of hornblende gneisses, and tremolite and quartzose schists, all of which are cut by granites,

[1] Newland, D. H., The mining and quarrying industry of New York State [in 1911]: Bull. N. Y State Mus. No. 161, 1912, pp. 101–105. McDonald, P. B., Zinc mining in New York: Eng. and Min. Jour., vol. 95, 1913, p. 362. Grugan, F. J., idem, p. 674.

pegmatites, and basic intrusives. The metamorphosed sediments strike northeast and dip about 45° NW. The zinc ores are in impure serpentine limestones and are thought by Newland [1] and Grugan [1] to be replacements, at least in part. Barite is found in both walls. According to McDonald,[1] there is considerable pyrite in the upper levels, but this gives way to purer blende at depth. The blende is dark and evidently carries iron. According to Grugan, the ore deposits have apparently filled open spaces as well as replaced limestone bodies.

NORTH CAROLINA.

The mine production in North Carolina in 1912 was 8,030.93 fine ounces of gold, valued at $166,014; 4,854 fine ounces of silver, valued at $2,985; 75,915 pounds of copper, valued at $12,526; 92,000 pounds of lead, valued at $4,140; and 283,320 pounds of zinc, valued at $19,549. The total value of the output was therefore $205,214, against $70,782 in 1911, when there was no output of copper, lead, or zinc, and when the gold production was $70,282 and the silver output was 943 fine ounces, valued at $500.

North Carolina produced over two-thirds of the gold output of the Eastern States in 1912, and the greater part of the production was from the Iola mine. Of the total output in the State, 22 placers produced 423.38 fine ounces of gold. From 14 deep mines, 7,321.95 fine ounces came from gold-quartz ores, 43.68 ounces from copper ores, and 241.92 ounces from lead ores. There were 14,358 short tons of siliceous ores treated, with an average precious-metal recovery of $10.62 per ton, and 500 tons of copper ore with a gold and silver recovery of $2.25 and a copper yield of 151.8 pounds per ton. There were also treated 1,215 short tons of lead-zinc ores yielding $5.33 in in precious metals and 167.3 pounds of lead and 108.4 pounds of zinc per ton.

The following table shows the production of gold, silver, copper, ead, and zinc in North Carolina for the years 1905 to 1912, inclusive:

Mine production of gold, silver, copper, lead, and zinc in North Carolina, 1905–1912.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	18,831	$125,685	20,230	480,000	.....	.....	$212,784
1906	20,368	82,131	30,769	703,775	.....	.....	238,575
1907	19,682	82,193	21,667	582,082	.....	.....	212,909
1908	9,088	97,495	1,260	19,393	.....	.....	100,723
1909	7,271	40,230	499	224,512	.....	.....	69,675
1910	14,914	68,045	9,053	140,514	.....	.....	90,778
1911	21,810	7.,282	943	.....	.....	.....	70,782
1912	16,073	166,014	4,854	75,915	92,000	283,320	205,214
Increase (+) or decrease (−) in 1912	−5,737	+95,732	+3,911	+75,915	+92,000	+283,320	+134,432

[a] Includes placer production.

There has been no output of copper, lead, or zinc in North Carolina in recent years until 1912, when there was the production of copper given from the Cullowhee mine, in Jackson County, and of lead and zinc from the Silver Hill mine, in Davidson County.

[1] Op. cit.

The following table shows the production of gold and silver, by counties, in North Carolina, in 1912:

Mine production of gold and silver in North Carolina in 1912, by counties.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		
Burke	48.38	$1,000	7	$4	$1,004
Cabarrus	22.98	475	.....	.....	475
Catawba	6.53	135	.....	.....	135
Davidson	241.92	5,001	2,394	1,471	6,472
Franklin and Halifax	118.57	2,451	5	3	2,454
Gaston and Guilford	2.85	59	.....	.....	59
Jackson	43.68	903	523	323	1,226
Mecklenburg	7.06	146	.....	.....	146
Montgomery	7,230.37	149,465	1,887	1,161	150,626
Randolph	16.79	347	7	4	351
Rowan	76.68	1,585	12	7	1,592
Rutherford	184.16	3,807	13	8	3,815
Stanley	6.77	140	.....	.....	140
Union	24.19	500	6	4	504
Total	8,030.93	166,014	4,854	2,985	168,999

Burke County.—The production of Burke County in 1912 was $1,000 in gold and 7 ounces of silver, valued at $4, a slight increase over the output for 1911, but below the yields of 1910 and 1909. The production was, as usual, chiefly from small placer operations in the Brindletown and Bridgewater sections.

Cabarrus County.—The gold output of Cabarrus County was $475 in 1912, against $1,567 in 1911. The production is mainly from incidental washings of small placers.

Catawba County.—There was a gold production of $135 from sluicing gravels in Catawba County in 1912, against an output of $7,148 for the county in 1911. The main gold yield of this county in recent years has been from the Shuford mine, and this was reported idle in 1912.

Davidson County.—A resumption of operations at the old Silver Hill mine, 10 miles south of Lexington, in Davidson County, resulted in the shipment of both lead and zinc concentrates and production of gold, silver, lead, and zinc in 1912. The mine was a producer of rich silver-lead ore many years ago, and has been worked at intervals over a period of 75 years. Little has been done in recent years, however, until 1911. The mine is opened by a main shaft 725 feet deep and has been equipped at various times with various plants for the treatment of the ores. The present plant includes 5 stamps, two 25-ton Deister slimers, and 3 double-hopper classifiers. The ore is mainly argentiferous lead-zinc sulphides, with minor quantities of auriferous iron and copper pyrites, and with gangue of igneous country rock metamorphosed to sericite schists[1] and slates, probably of pre-Cambrian age.

Franklin County.—The Portis dredge, operating near Wood in Franklin County, made a small output of gold in 1912.

Gaston County.—At the Logan property, in Gaston County, shaft sinking was in progress and work was also done upon the erection of

[1] Pogue, J. E., The Cid mining district of Davidson County, N. C.: Bull. North Carolina Geol. and Econ. Survey No. 22, 1910, pp. 98–103.

a mill in 1912. At the Catawba-King's Mountain mine repair work was done. A nominal placer output was reported from this county in 1912.

Granville County.—In the Virgilina district, in Granville County, some recent prospect work has been reported at the Holloway copper mine. The Blue Wing mine has been unwatered and new development work has begun. The Copper King has changed ownership, and development work was in prospect.

Guilford and Halifax counties.—A nominal output of placer gold was reported from Guilford and Halifax counties in 1912.

Jackson County.—The Cullowhee copper mine, near Webster, in Jackson County, produced gold, silver, and copper from matte made and shipped in 1912. The mine is opened by a shaft 177 feet deep and by a 300-foot adit. The equipment includes a 30-ton water-jacketed smelter in which low-grade matte is made for shipment. The ore is sulphide with siliceous gangue. According to Weed,[1] the ore bodies occur on the contact of pre-Cambrian amphibolite and Carolina gneiss. The deposit is relatively low grade, and the ore is chalcopyrite in bunches and films and disseminated through pyrite. Chalcocite and covellite also are found. Portions of the ore are rich in corundum, and this very hard mineral has made prospecting by diamond drilling expensive.

Mecklenburg County.—The gold dredge of the Piedmont Placer Mining Co., operating on Catawba River, near Charlotte, produced no gold in 1912, but was profitably worked for gravel and sand which was used in the concrete construction of a bridge across the river. There was only a nominal output of placer gold from this county in 1912. It has been reported that a Partridge smelter has been erected near Charlotte with the view to the treatment of old dumps and mixed ores from North Carolina and South Carolina.

Montgomery County.—The production of Montgomery County was $149,465 in gold, and 1,887 fine ounces of silver, valued at $1,161, a total value of $150,626, in 1912, against an output of $55,780 in gold and 762 ounces of silver, valued at $404, in 1911. The Iola mine, with greatly increased output, was the largest gold producer east of the Black Hills in 1912. The mine is opened by a 650-foot vertical shaft and is equipped with a 50-ton mill and cyanide plant, including 5 stamps of 1,750 pounds each (the heaviest stamps used in the United States), Dorr classifier, tube mill, Parral agitators, and Kelly filters. The ore is both sulphide and oxidized. Treatment cost averages $1.64 per ton, of which $1.005 is for milling and $0.635 for cyaniding. There have been frequent recent references[2] to this mine, which is one of the newest and yet has been one of the few really important gold producers of the South during the last 12 or 13 years. At the Uwarra (old Montgomery) mine over 2,000 feet of development work was done in 1912. The mine is opened by 150-foot and 300-foot vertical shafts and 4,000 feet of drifts and raises. A 50-ton fine grinding and cyanide plant was in prospect. A small gold

[1] Weed, W. H., Copper deposits of the Appalachian States: Bull. U. S. Geol. Survey No. 455, 1911, pp. 138–140.

[2] Pratt, J. H., The mining industry in North Carolina during 1906: Econ. Paper North Carolina Geol. and Econ. Survey No. 14, 1907, pp. 50–51; No. 15, 1908, pp. 13–16. Hafer, Claud, Notes on gold mining in North Carolina: Min. World, vol. 28, 1908, pp. 332–333; a North Carolina mining enterprise: Min. and Sci. Press, vol. 106, 1913, pp. 728–729. Lyon, E. W., The progress of gold mining in North Carolina: Eng. and Min. Jour., vol. 87, 1909, pp. 295–296. Barbour, P. E., Iola cyanide mill, Candor, N. C.: Eng. and Min. Jour., vol. 94, 1912 pp. 505–509.

output was reported from the Sallie Coggins mine, but the Old Coggins was reported idle. There was a nominal production of placer gold also reported from Montgomery County in 1912.

Randolph County.—At the Ashboro mine in Randolph County the recent placer work has not been successful, but over six months were spent in prospecting in 1912 and the location of several promising ore shoots was reported. At the Redding mine, near Cedar Falls, but little work was done in 1912. At the Davis Mountain or Conroy placer experiments were made in treating surface material in McCutcheon and Marathon mills, resulting in a small output of gold. At the Southern Homestake prospecting only was done. A nominal production of placer gold was reported from Randolph County in 1912.

Rowan County.—The gold production of Rowan County was $1,585 in 1912, against $1,301 in 1911. At the Steele placer a small output was made by hand sluicing. A nominal production was made from working old dumps of the Gold Hill mines by hand rockers, but the tailings of the McMackin mine yielded the chief output of gold.

Rutherford County.—The production of gold in Rutherford County was $3,807 in 1912, against a nominal output in 1911. The main producer was the Biggerstaff placer.

Stanley and Union counties.—There was a nominal output of gold from Stanley and Union counties in 1912.

PENNSYLVANIA.

There has been no production of gold, silver, lead, or zinc ores reported from Pennsylvania for many years, but since 1907 there has been annually a copper production yielding small quantities of silver and gold in refining. The greater part of the output has been from the Cornwall iron mine.

The following table shows the tonnage of ore producing copper, silver, and gold, and their output in Pennsylvania from 1907 to 1912:

Tonnage of ore treated and mine production of metals in Pennsylvania, 1905–1912.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	
1905					
1906					
1907					
1908	[a] 57,269	$704		186,869	$25,371
1909	191,198	4,941	43	621,969	85,819
1910	218,183	5,640	50	927,360	123,442
1911	219,368			642,902	80,363
1912	214,000			473,060	78,055
Decrease, 1912	5,368			169,842	2,308

[a] Estimated.

Adams and Franklin counties.[1]—In Adams County the Bigham mine produced from open cuts several hundred tons of ore reported

[1] Wherry, E. T., The copper deposits of Franklin-Adams counties, Pa.: Jour. Franklin Inst., vol. 171, No. 2, 1911, pp. 151–163.

to be of smelting grade, but there were no shipments or treatment of ore from this property in 1912. At the Eagle Metallic mine, which is opened by a 480-foot shaft, some material was treated in the 150-ton copper smelter, recently erected, and a small quantity of low-grade matte was reported produced and shipped. Just across the line from Adams, in Franklin County, is the Virgin copper property, at which development work only was reported in 1912.

Lebanon County.—At the Cornwall iron mines, in Lebanon County, an important tonnage of pyritiferous magnetite was again treated by the Gröndahl process, resulting in briquetted copper-bearing pyrite, which was shipped to copper smelters, and clean, high-grade magnetite. The ore is taken from open cuts, and the plant includes a 1,000-ton concentrator.

SOUTH CAROLINA.

The mine production of gold in South Carolina in 1912 was 818.26 fine ounces, valued at $16,915, and that of silver was 47 ounces, valued at $29, a decrease of $3,493 in value of gold but an increase of $23 in value of silver for 1912. There was no output of copper, lead, or zinc in South Carolina in either 1911 or 1912. The yield of 1912 was mainly from deep mines, only 20.27 fine ounces of gold and no silver being reported from five small placers. Seven deep mines produced 12,358 short tons of siliceous gold ore yielding an average recovery of $1.34 in precious metals per ton, against an output of 9,302 tons in 1911 with an average recovery of $2.17.

The following table shows the output of South Carolina for the years 1905 to 1912, inclusive:

Tonnage of ore treated and mine production of metals in South Carolina, 1905–1912.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	
1905	49,493	$95,111	111	.....	$95,178
1906	49,327	78,959	92	.....	79,021
1907	36,195	54,765	124	.....	54,847
1908	16,795	53,715	226	1,600	54,046
1909	3,150	11,053	44	.....	11,076
1910	24,153	38,324	46	.....	38,349
1911	9,302	20,408	11	.....	20,414
1912	12,358	16,915	47	.....	16,944
Increase (+) or decrease (−) in 1912	+3,056	−3,493	+36	.....	−3,470

[a] Includes placer gold and silver.

Abbeville County.—At the Neel property, near Abbeville, in Abbeville County, a small tonnage of ore was treated in a light 5-stamp mill. Two veins of auriferous sulphides have been exposed, and the ore is reported to run from $6 to $81 per ton in gold. The McCormick Mining Co. did considerable prospecting in 1912 and treated free milling ore in a 10-stamp mill. Some of the ore produced was manganiferous, and all of that treated was superficially altered.

Cherokee County.—A nominal output of placer gold was reported from Cherokee County in 1912. The Flint Hill mine, near Gaffney, was being equipped with a 40-ton milling plant.

Lancaster County.—The Haile mine, near Kershaw, in Lancaster County, produced a considerable tonnage of low-grade ore, as usual, and produced the greater part of the gold yield of the State in 1912 as in previous years.

Spartanburg and Union counties.—A nominal output of placer gold was reported from Spartanburg and Union counties in 1912.

York County.—In York County the Wolf Creek mine was prospected and development resulted in the shipment of oxidized gold ore to copper smelters in 1912. The amalgamation plant includes a 10-ton centrifugal McClain mill and La Point separators, but the mill was not completed for operation in 1912.

TENNESSEE.

The production in Tennessee in 1912 was 399.82 fine ounces of gold, valued at $8,265, and 89,893 fine ounces of silver, valued at $55,284, a decrease of $3,356 in gold and of $1,246 in value of silver. The output of copper was 18,483,173 pounds, valued at $3,049,724, against 18,850,276 pounds in 1911, valued at $2,356,285; and the production of zinc was 4,381,300 pounds, valued at $302,310, against 2,234,000, valued at $127,338 in 1911. The total net increase in output of these metals of Tennessee for 1912 was therefore valued at $863,809.

There were no gold, silver, or lead mines reported productive in Tennessee in either 1912 or 1911, and the entire output of gold, silver, and copper in 1912 was from 603,229 short tons of copper ore, which yielded an average of $0.105 in precious metals and of 30.6 pounds of copper per short ton treated.

The zinc production was entirely from 32,347 short tons of zinc ores, which yielded an average of 135.4 pounds of zinc (figured as spelter), and no precious metals per short ton of crude ore treated. There has been an extensive campaign of active prospecting by drilling in the zinc region of eastern Tennessee during the last few years, but the general results have developed fewer new fields than at first expected. Large bodies of ores have been located by drilling on the old Holston property by the American Lead, Zinc & Smelter Co., however, and the American Metal Co. and the New Jersey Zinc Co. have also come into the field and obtained option on large tracts of land for the purpose of prospecting them.

The zinc deposits of Tennessee have been recently described by Purdue.[1]

The following table shows the output of Tennessee for the years 1905 to 1912, inclusive:

[1] Purdue, A. H., The zinc deposits of northeastern Tennessee: Bull. Tennessee Geol. Survey No. 14, 1912.

Tonnage of ore treated and mine production of metals in Tennessee, 1905–1912.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	399,330	$4,362	95,522	14,541,425	.....	$2,330,606
1906	538,141	4,838	55,931	17,979,317	.....	3,512,320
1907	561,805	3,825	58,358	18,893,115	218,643	3,333,864
1908	638,033	3,699	57,696	19,459,501	688,149	2,635,275
1909	611,014	4,118	57,637	19,206,806	1,192,161	2,595,350
1910	578,434	3,113	81,239	16,837,727	1,932,555	2,289,731
1911	604,538	11,621	106,660	18,850,276	2,234,000	2,551,774
1912	635,576	8,265	89,893	18,483,173	4,381,300	3,415,583
Increase (+) or decrease (−) in 1912	+31,038	−3,356	−16,767	−367,103	+2,147,300	+863,809

[a] Includes placer gold and silver.

Jefferson County.—An increased production of zinc was again reported from Jefferson County in 1912. The Loy mine produced zinc carbonate ores which were concentrated in a mill whose capacity is rated at 150 tons in 10 hours. The equipment includes washers, crushers, rolls, jigs, and tables. A locomotive crane was added in 1912. The mine is worked by open cuts and by 4 shafts with a maximum depth of 70 feet.

Knox County.—The old Holston property, near Mascot, in Knox County, has recently been extensively explored by drilling, and large quantities of zinc blende have been reported available for mining and milling. One shaft has been sunk 380 feet and another will probably go to 800 feet. A 1,000-ton mill was in course of erection to treat the ores of this mine.

Polk County.—The Polk County, Burra-Burra, Eureka, and London mines of the Tennessee Copper Co., and the Mary and East Tennessee mines of the Ducktown Sulphur, Copper & Iron Co., all in the Ducktown district of Polk County, were again actively operated and large producers in 1912. The Burra-Burra shaft is down 820 feet, the London 588 feet, the Polk County 485 feet, the Eureka 165 feet, the Mary 835 feet, and the East Tennessee 693 feet. The ores mined are sulphides, mainly copper-bearing pyrrhotite and pyrite, and chalcopyrite. Both mining companies operate large smelters and the recovery of sulphuric acid as a by-product is a material source of profit.

VIRGINIA.

The production of gold in Virginia was 10.54 fine ounces of gold, valued at $218, in 1912, against 148.22 ounces, valued at $3,064, in 1911. The yield of silver was 982 fine ounces, valued at $604, against 21 ounces, valued at $11, in 1911. The production of copper increased from 90,000 pounds, valued at $11,250, in 1911, to 112,835 pounds, valued at $18,618, in 1912, but the output of lead decreased from 830,542 pounds, valued at $37,374, in 1911, to 469,026 pounds, valued at $21,106, in 1912. The production of zinc also decreased from 2,064,818 pounds (figured as smelter), valued at $117,695, in 1911, to 497,235 pounds, valued at $34,309, in 1912. The decline in value of the production of all the five metals combined was $94,539 for 1912.

The small gold production reported from Virginia in 1912 was all from siliceous ores, of which 45 tons were treated with an average precious metal recovery of $2.98 per ton. The silver and copper yield were derived from 1,160 short tons of copper ores (and from mine waters). The lead and zinc production was derived from 4,585 short tons of lead and lead-zinc ores. Six deep mines and no placers were reported productive in Virginia in 1912.

The following table shows the production of gold, silver, copper, lead, and zinc in Virginia for the years 1905 to 1912, inclusive:

Tonnage of ore treated and mine production of metals in Virginia, 1905–1912.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	800	$4,982	177	.....	.....	.....	$5,087
1906	1,000	14,832	250	.....	.....	.....	15,000
1907	26,822	8,288	221	58,880	118,400	.....	26,485
1908	12,877	2,451	236	24,775	76,190	1,410,961	75,361
1909	14,075	3,750	4,825	224,162	.....	116,627	41,698
1910	16,976	888	128	5,402	198,850	1,588,112	96,151
1911	17,782	3,064	21	90,000	830,542	2,064,818	169,394
1912	5,790	218	982	111,835	469,026	497,235	74,855
Increase (+) or decrease (−) in 1912	−11,992	−2,846	−961	+21,835	−361,516	−1,567,583	−94,539

[a] Includes placer gold and silver.

Fauquier County.—The Emigold prospect, near Goldvein, in Fauquier County, made a nominal production of gold in 1912.

Fluvanna County.—The Scotia property, near Columbia, in Fluvanna County, was not worked in 1912, but renewed operations were in prospect for 1913.

Goochland County.—There was a nominal output of gold from Goochland County in 1912.

Halifax County.—There was no production from the copper mines of the Virgilina district in Halifax County (and in Person and Granville counties across the line in North Carolina) in 1912. The Poole gold mine was under development and the erection of a stamp mill was contemplated, and the Seaboard copper mine was acquired by new interests during the year.

Louisa County.—In Louisa County the Sulphur (pyrite) mine again produced cement copper in 1912 from the mine waters, but there was no output of copper, lead, or zinc reported from the Armenius pyrite mine.

Prince William County.—The Cabin Branch pyrite mine, near Dumfries, produced copper and silver in 1912.

Spotsylvania County.—There was no ore production or output of metals in 1912 from the mixed gold-silver-lead-zinc-pyrite ores of the Grindstone or Holladay properties, which lie in a northeast extension of the pyritic mineral belt of Louisa County. The Holladay property was under development by the Bertha Mineral Co., and the sulphide vein was reported 15 to 20 feet wide at a depth of 150 feet. Increased activity was in prospect for 1913.

Wythe County.—There was an important output of lead and zinc from the Austinville, Bertha, and Little Wythe mines in Wythe

County in 1912. The Austinville mine produces both lead and zinc and the Bertha mine zinc only. The output is from both ore and old tailings, which are concentrated. A small tonnage of ore was also shipped crude. Part of the concentrates and soft ore were treated in the Austinville oxide plant and the remainder was shipped. At the Little Wythe mine, near Cripple Creek, the principal production is of iron ore, but as zinc sulphides are encountered in streaks they are mined, hand-sorted, and shipped crude to zinc smelters.

SURVEY REFERENCES.

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PRECIOUS AND SEMIPRECIOUS METALS IN THE CENTRAL STATES IN 1912.

(MINE PRODUCTION.)

By B. S. Butler and J. P. Dunlop.

INTRODUCTION.

By J. P. Dunlop.

The following is an account of the production of silver, copper, lead, and zinc in 1912 by the mines of the Central States, including Arkansas, Iowa, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States which extends from the Appalachian system to the Rocky Mountain front, excluding the Black Hills. Most of the mines are developed in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each mine in operation and represent the quantity of metals recovered or paid for in the ore that was treated or sold during the year.

Statistics of mine production were first collected for Michigan for 1906. The mine census of all of the Central States was first undertaken for the year 1907. A comparison of the total production of these metals by States as reported from the mines and from the smelters will be found in the chapters on those metals in the complete volume.

The method of marketing and recording the mine output in the lead and zinc regions of the Central States differs from that employed in the Western States. In the Western States the miner usually sells his ore according to the assay content of metal at a certain price per unit. In the lead and zinc regions of the Central States, however, where the material sold is principally concentrates,[1] payment is made according to a basis price for a certain quality of concentrate. The details of this method are given in the pages devoted to Missouri. The figures reported to the Survey by producers represent the tonnage and assay content of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

[1] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted. In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced during the year but not smelted has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES.

Much of the ore mined in the Western States is crude smelting ore—that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of tonnage of crude ore, or "dirt," as it is usually called in the Central States lead and zinc regions. However, in those States it is only the larger companies which make any record of the crude ore raised. In the Joplin region the number of cans of ore hoisted is usually recorded and the approximate weight of the cans is generally known. Thus each company knows, in a general way, about what percentage of concentrates the mine run is yielding. Knowing the total production of concentrates and the average yield of concentrates from crude ores, one can arrive at a close estimate of the crude ore raised. The quantity of crude lead and zinc ores raised has been requested annually on the United States Geological Survey schedules since the mine census was undertaken in the Central States in 1907, and for many of the mines it has been reported. Only the actual operating companies have the data, however, and it is the practice of the Survey, in order to shorten the list of producers as much as possible, to send requests only to the owners of the mining land or the companies holding first leases and to depend upon them to report the whole production of the tract. In this way the crude ore formerly reported was such a small fraction of the total that it was not considered advisable to use it. In 1909, however, the general census necessitated a report from every operator and the data in regard to crude ore were so much more complete that the average percentage of concentrates in the crude ore was calculated from those schedules in which the crude ore was given. This was done for each State, and in Missouri separate calculations were made for the "soft ground" and the "sheet ground" of southwest Missouri and for the disseminated lead ore of southeast Missouri. These average percentages were applied to the total concentrates produced, thus working back to the total quantity of crude ore raised. Since 1909 the data furnished upon the mine schedules have been sufficient to permit the continuance of the crude-ore calculations. In 1912 not only the first lessees of the land reported to the Survey, but also most of the sublessees gave data regarding both concentrates produced and "dirt" or ore milled. The tables of ore tenor which follow in the sections devoted to the respective States show the comparative percentages for the last two years. In certain States, notably Iowa, Kentucky, and the southern part of Illinois, it was not possible or advisable to make such calculations.

In Kentucky and southern Illinois the lead and zinc ores are recovered as by-products in the concentration of the fluorspar which they accompany. In Iowa in 1909, 1910, 1911, and 1912 the quantity of ore raised was so small and the number of producers so limited that the calculation of averages and of the crude-ore production would be misleading.

Tenor of copper, lead, and zinc ores of Central States, 1910–1912.

State.	1910		1911		1912	
	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*	*Short tons.*	*Per cent.*
Arkansas	35,000	3.4	24,925	3.4	32,755	2.8
Illinois (northern)	110,078	3.8	153,313	3.6	147,859	3.6
Kansas	704,046	2.5	761,465	1.9	744,254	1.9
Michigan	10,869,561	1.025	10,978,827	1.0	11,411,941	.96
Missouri	12,748,420	2.3	12,136,788	2.5	13,385,511	2.4
Oklahoma	223,212	4.0	224,450	2.9	293,500	3.1
Wisconsin	1,032,031	3.6	1,123,040	3.4	1,363,636	3.1

[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper; in the other Central States the metals are lean and zinc, the relative proportions of which are shown in the table on another page and in the tables of ore tenor given in the sections devoted to the respective States.

This table shows that from copper, lead, and zinc mines of the Central States 27,379,390 short tons of ore were treated in 1912, an increase of 1,976,582 tons in comparison with 1911. The tonnage of ore mined and treated from copper, lead, and zinc mines in the Central States in 1912 was approximately 4,400,000 tons more than all the copper, lead, zinc, and lead-zinc ores sold or treated by mines in the Eastern and Western States in 1911, and over 20 per cent of all the metallic ores from domestic mines sold or treated in 1911. The low average tenor of the metal content of Central States crude ore is strikingly shown by the fact that, while the average price of copper, silver, and zinc was much higher than for several years, the average value of the recoverable metal content was only $2.91 per ton of crude ore.

PRODUCTION.

The total value of the output of silver, copper, lead, and zinc in the Central States in 1912 was $79,675,814, an increase of $15,156,370 over the value for 1911 and of $23,349,111 over that for 1908. The total value of the production of these metals for the years 1908 to 1912, inclusive, was $327,385,994, of which $151,830,008 was for copper, $98,188,656 for zinc, $76,217,618 for lead, and $1,150,512 for silver.

SILVER.

The production of silver in the Central States in 1912 was 568,622 fine ounces, which at the average price of 61.5 cents per fine ounce (8.5 cents higher than in 1911) was valued at $349,702, as compared with 550,184 fine ounces, valued at $291,598 in 1911. No silver ores are worked in the Central States, and the silver that is produced is recovered incidentally to the production of other metals. Of the 1912 production, 528,453 ounces came from the copper lodes of

Michigan, an increase of 31,172 ounces. The lead ores of southeast Missouri yielded 35,438 ounces, a decrease of 14,429 ounces. The lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, and from the lead concentrates derived from Illinois, 4,731 ounces of silver were recovered, an increase of 1,695 ounces. The quantity and value of the silver recovered from copper and lead ores in the Central States has steadily increased during the last five years.

COPPER.

The output of copper from the Central States in 1912 was from the States of Michigan and Missouri, the former State contributing nearly the entire output. The copper production of Michigan in 1912 was 218,138,408 pounds, which, at the average New York price of 16.5 cents per pound, was valued at $35,992,837, compared with a yield of 219,840,201 pounds, valued at $27,480,013, in 1911. The copper produced in Missouri in 1912 amounted to 440,725 pounds, valued at $72,719, and was derived from concentrates recovered in dressing the lead ores of southeast Missouri.

The production in 1912 was less than in the years 1911, 1910, 1909, and 1908, but the value, owing to the high average price in 1912, was over $7,500,000 larger than in 1911, and over $6,600,000 larger than in 1909, although the output for 1909 exceeded that of 1912 by more than 5,500,000 pounds.

LEAD.

The mine production of lead in the Central States in 1912 was 186,891 short tons, which, rated at the average New York price for the metal for the year of 4.5 cents a pound ($90 a ton), the same as in 1911, was valued at $16,820,190, as compared with 188,669 short tons, valued at $16,980,210, in 1911. Although the output of lead decreased 1,878 tons in 1912, it was only 1 per cent less than in 1911, and was 22 per cent larger than in 1908. In 1912 Missouri produced 95 per cent of the lead yield of the Central States and over 43 per cent of the primary lead recovered in the United States from domestic ore. Of the total lead output of Missouri the disseminated lead district of southeast Missouri produced 146,913 tons, again exceeding the yield from the Coeur d'Alene district of Idaho, and retaining first place in lead production in the United States. Southwest Missouri was the next largest producing district in the Central States. Oklahoma increased its lead production about 25 per cent, and for the first time its output was larger than that of either Wisconsin or Kansas.

ZINC.

The production of zinc in the Central States in 1912, based on mine returns with a deduction for separating and smelting losses, was 191,307 short tons, valued at $26,440,366. The value is computed at 6.9 cents per pound of spelter ($138 per ton), the average St. Louis price for the metal. The 1911 production was 172,698 short tons, valued (at $114 per ton) at $19,687,572. The increase in 1912 was 18,709 tons in quantity and $6,752,794 in value. The output in 1912 was more than 45,000 tons larger than in 1908, and the value almost doubled. The spelter production of the Central

States was over 59 per cent of the total production of primary spelter from domestic ores in the United States in 1912.

The State of Missouri was again in 1912 much the largest producer of zinc in the United States. Its production was 136,551 tons, against 122,515 tons in 1912. Wisconsin produced 33,050 tons in 1912, against 29,720 tons in 1911. The output from Arkansas, Kansas, Kentucky, and Oklahoma increased. Illinois showed a small decrease.

SUMMARY OF PRODUCTION BY STATES.

The total value of the output of silver, copper, lead, and zinc in the Central States in 1912 was $79,675,814, as appears from the following table:

Production of silver, copper, lead, and zinc in the Central States in 1912, by States.

State.	Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Pounds.*		*Short tons.*		*Short tons.*		
Arkansas	.....	.....	.....	.....	31	$2,790	748	$103,224	$106,014
Illinois	4,731	$2,909	.....	.....	1,282	115,380	4,065	560,970	679,259
Iowa	.....	.....	.....	.....	63	5,670	.....	.....	5,670
Kansas	.....	.....	.....	.....	2,371	213,390	10,633	1,467,354	1,680,744
Kentucky	.....	.....	.....	.....	106	9,540	491	67,758	77,298
Michigan	528,453	324,999	218,138,408	$35,992,837	.....	.....	.....	.....	36,317,836
Missouri	35,438	21,794	440,725	72,719	177,069	15,936,210	136,551	18,884,038	34,914,761
Oklahoma	.....	.....	.....	.....	3,388	304,920	5,769	796,122	1,101,042
Wisconsin	.....	.....	.....	.....	2,581	232,290	33,050	4,560,900	4,793,190
Total	568,622	349,702	218,579,133	36,065,556	186,891	16,820,190	191,307	26,440,366	79,675,814
Total, 1911	550,184	291,598	220,480,513	27,560,064	188,669	16,980,210	172,698	19,687,572	64,519,444
Total, 1910	365,702	197,479	222,777,913	28,292,795	171,226	15,067,888	178,784	19,308,672	62,866,834
Total, 1909	301,629	156,848	234,136,529	30,437,749	168,221	14,467,006	175,337	18,936,396	63,997,999
Total, 1908	292,237	154,885	223,286,700	29,473,844	153,361	12,882,324	146,975	13,815,650	56,326,703

LEAD AND ZINC PRODUCTION BY REGIONS.

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to any single State. For statistical purposes the tables showing the production of lead and zinc, by States, are necessary and are so given.

For practical purposes, however, it seems desirable to compile the production by the natural regions irrespective of State lines.

The seven regions are as follows, in order of importance of output: (1) The Joplin region, comprising the district in southwest Missouri, southeast Kansas, and northeast Oklahoma; (2) southeast Missouri, containing the great disseminated lead deposits; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwest Wisconsin, Iowa, and northwest Illinois; (4) the Kentucky-Illinois fluorspar region in southern Illinois and northern Kentucky; (5) northern Arkansas; (6) Central Missouri;[1] (7) the Arbuckle Mountain region in southern Oklahoma.

The southeast Missouri region produced about 79 per cent of the lead output of the Central States, and about 35 per cent of the pro-

[1] Owing to the small output from the central Missouri region it has in this report, for convenience, been included in the southeast Missouri region.

duction of lead recovered from domestic ore in the United States in 1912. The Joplin region produced 19 per cent of the lead and 80 per cent of the zinc of the Central States in 1911, and was much the largest producer of zinc in the United States, yielding about 47 per cent of the total zinc production from domestic ores. The upper Mississippi region produced less than 2 per cent of the lead and 19 per cent of the zinc produced in the Central States in 1912.

Production of lead and zinc in the Central States in 1912, by regions, in short tons.

Region.	Concentrates.			
	Lead.[a]		Zinc.[b]	
	Quantity.	Value.	Quantity.	Value.
Joplin	45,328	$2,490,315	299,421	$14,462,081
Southeast Missouri[c]	218,803	9,849,854	1,091	22,312
Upper Mississippi Valley	4,315	232,408	120,451	3,349,229
Kentucky-Southern Illinois	948	45,477	1,243	41,391
Northern Arkansas	39	2,180	1,881	67,466
Arbuckle Mountain, Okla			250	10,000
Total	269,433	12,620,234	424,337	17,952,479
Total, 1911	270,833	13,138,430	381,579	12,616,542

Region.	Metal.				Total value of metal.
	Lead.		Zinc.		
	Quantity.	Value.	Quantity.	Value.	
Joplin	35,915	$3,232,350	152,465	$21,040,170	$24,272,520
Southeast Missouri[c]	146,913	13,222,170	378	52,164	13,274,334
Upper Mississippi Valley	3,331	299,790	37,115	5,121,870	5,421,660
Kentucky-Southern Illinois	701	63,090	491	67,758	130,848
Northern Arkansas	31	2,790	748	103,224	108,014
Arbuckle Mountain, Okla			110	15,180	15,180
Total	186,891	16,820,190	191,307	26,400,366	43,222,556
Total, 1911	188,669	16,980,210	172,698	19,687,572	36,667,782

[a] Includes both galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.
[c] Includes a small production from the central Missouri region.

ARKANSAS.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Arkansas in 1912 is shown in the following table:

Production of lead and zinc in Arkansas, 1908–1912, in short tons.[a]

	Ore.						Metal content.			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
	Galena.		Sphalerite.		Silicate and carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1912	39	$2,180	1,419	$56,235	462	$11,231	31	$2,790	748	$103,224
1911	80	4,321	1,407	40,425	183	4,239	64	5,760	664	75,696
1910	80	3,714	1,857	74,136	128	2,641	63	5,544	994	107,352
1909	30	1,800	896	33,948	98	2,736	24	2,064	510	55,080
1908	18	985	516	18,270	939	21,469	15	1,260	605	56,870

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the values given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Tenor of lead and zinc ore and concentrates produced in Arkansas in 1911 and 1912.

	1911	1912
Total crude ore sold.....short tons..	24,925	32,755
Total concentrates in crude ore:		
Lead.....per cent..	.3	.1
Zinc.....do....	6.4	5.7
Metal content of crude ore:		
Lead.....do....	.2	.1
Zinc.....do....	3.2	2.7
Average lead content of galena concentrates.....do....	80.0	79.5
Average zinc content of sphalerite concentrates.....do....	50.2	49.0
Average zinc content of zinc silicate and carbonate.....do....	39.1	38.0
Average value per ton:		
Galena concentrates	$54.01	$55.90
Sphalerite concentrates	28.73	39.63
Zinc silicate and carbonate	23.16	24.31

NORTHERN ARKANSAS.

Lead and zinc deposits have been known in Arkansas for many years. Lead was noted by Schoolcraft in his travels in 1819, and has been mined in a desultory way since the settlement of the State. Present development dates from about 1899, when there was a great rush to the northern Arkansas field. The mines are principally in Marion County and in the adjoining portions of Searcy, Newton, and Boone counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east,

and a deposit has recently been developed in Washington County, on the extreme west border of the State.

The ores are galena, sphalerite, and smithsonite. The sphalerite is generally very high grade, the concentrates, when clean, ranging well above the price basis, 60 per cent metallic zinc content. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, a yellow variety of smithsonite, known locally as "turkey fat," showing as high as eight-tenths of 1 per cent of cadmium. The ore bodies occur in fissures or crevices, in fault breccias, and in solution breccias. The ore deposits are for the most part found in the Yellville limestone, of Ordovician age, but some also are found in the Boone limestone, of lower Carboniferous age.

Until the last three years the mines labored under the disadvantage of a long wagon haul to the railroad and of high freight rates. Other handicaps are the lack of keen competition among ore buyers and the added cost and the loss of time in obtaining supplies and repairs, though these conditions have improved with the development of the field. The completion of the White River branch of the St. Louis, Iron Mountain & Southern Railway and of the St. Louis & North Arkansas Railroad has brought most of the producing mines within 10 miles of railway transportation and greatly improved the situation in this regard. Land for mining purposes is ordinarily leased in 10-acre tracts at 10 per cent royalty. Wood is universally used for fuel at the mines. Since 1907 the number of steam-concentrating plants in the northern Arkansas region has always been above 20, but usually not more than a third of them has been in operation in any one year. These are of the Joplin type and average about 100 tons in daily capacity. Mining methods are similar to those in vogue in the Joplin region except that, owing to the rugged character of the country, many deposits have been found outcropping on the hillside and have been followed in by tunnels. Shallow deposits are won by open pits. Hand drills are generally used, though a few of the larger plants have installed air or steam drills. Prospecting is done by means of the churn drill, and an encouraging feature of recent work has been the greater depth to which prospecting has been carried.

The assistance rendered by Prof. R. W. Willett in the preparation of this account of the lead and zinc production of Arkansas is gratefully acknowledged.

In 1912 there were 17 shippers of lead or zinc concentrates against 12 shippers in 1911, and the value of the mine output of lead and zinc increased $27,528. The production of galena concentrates declined from 80 short tons in 1911 to 39 tons in 1912. The production of sphalerite concentrates was 1,419 tons, only 9 tons more than in 1911, but owing to the higher prices paid for concentrates the value was $15,810 more than in 1911. The zinc carbonate and zinc silicate concentrates increased from 183 tons, valued at $4,239, in 1911, to 462 tons, valued at $11,231, in 1912. Mines in Marion County produced about two-thirds of this class of ore, and nearly all the remainder was derived from Newton County. The quantity of ore milled was about 8,000 tons larger in 1912 than in 1911, but the percentage of concentrates in crude ore declined from 6.7 to 5.8. The average grade of all classes of zinc and lead concentrates was slightly less than in 1911. A

large proportion of the zinc concentrates sold were mixed sphalerite and carbonate in the approximate proportion of 3 to 1. The average price paid for all concentrates was higher in 1912 than in 1911 despite the lower metal content. The average price per ton received by shippers of sphalerite concentrates was $39.63, which was $10.90 more than in 1911.

REVIEW BY DISTRICTS.

Dodd City district.—No production of concentrates was reported from this district in 1912. The Rising Sun, North Star, Onwatta, Beatty, Governor Eagle, Pilot Rock, and Nakomis mines were all idle. At the Boone County mine the mill on the property was repaired and ore of good grade was being taken from an open cut.

Maumee district.—The Maumee mine, which has a shaft 138 feet deep and is equipped with a 100-ton concentrating plant, made no shipments in 1912. The property will probably be operated in 1913 by new lessees.

The lessees on the land owned by the Granby Mining & Smelting Co. are generally the largest producers of galena and zinc carbonate and silicate concentrates in Arkansas, but the 1912 output was much smaller than usual.

Rush district.—The mines of the Rush district, in Marion County, produced over 88 per cent of the sphalerite concentrates shipped from Arkansas in 1912.

The Red Cloud mine, in this district, produced over 50 per cent of the zinc concentrates shipped from Arkansas in 1912. The mine is opened by an 800-foot tunnel and the property is equipped with a 200-ton concentrating plant, which was operated from April to December. The concentrate produced is a mixture of sphalerite and zinc carbonate in approximately equal quantities, which averages 46.5 per cent zinc and contains very little iron or lime.

At the Yellow Jacket (Philadelphia) mine a 100-ton mill was operated part of the year and was the second largest producer in Arkansas in 1912. The concentrate shipped was mixed sphalerite and zinc carbonate in the proportion of 3 parts sphalerite to 1 carbonate.

The new 250-ton concentrating plant at the Morning Star mine was put in operation, and a fair output of sphalerite was shipped.

Zinc and Sugar Orchard districts.—The mines in these districts in Marion County were the largest producers of zinc carbonate and silicate in Arkansas in 1912, and also yielded 135 tons of sphalerite concentrates. The Frisco mine, under lease to L. L. Brown, was the largest producer of zinc carbonate and silicate in Arkansas. The ore body, which varies from a few inches to 10 feet in thickness, is mined through several tunnels on both sides of a small creek. The longest tunnel is 150 feet in length, and the lowest depth from which ore was extracted was 50 feet. Several hundred tons of mill dirt were extracted in addition to the quantity of rough ore shipped. The shipping ore was hand cobbed (not washed) and averaged 41 per cent metal content. Other shippers of zinc carbonate and silicate were the Wilmath & Brandt and the Coker Hollow mines. There were many prospectors and small operators working in the district during the latter part of 1912, and the production of zinc from shallow mines will probably increase in 1913.

The Iola Mines Co. was the largest producer of sphalerite in the zinc district in 1912. A 100-ton concentrating plant was operated, and the concentrates produced averaged 62.4 per cent zinc content.

The Tar Kiln mine of the Federal Exploration Co. also shipped sphalerite concentrates of approximately 63 per cent zinc content. There are two shafts, one 105 and the other 90 feet deep, and the concentrating plant has a capacity of 100 tons.

The J. E. Wheeler lease on land of the Washington Mining Co. was the only large producer of galena concentrates in Arkansas in 1912. The shaft at this mine is 70 feet in depth and the galena was extracted from drifts at the 50-foot level.

Morrow district.—A small quantity of lead and sphalerite concentrates were shipped by the Morrow Mining Co. from its property near Cane Hill in Washington County, on the extreme western border of the State. The mining so far has been by means of open cuts. The mine is equipped with a 150-ton concentrating plant.

Ponca and other districts in Newton County.—The mines in Newton County produced 137 tons of zinc carbonate and silicate in 1912. The Bennett mine, in sec. 35, T. 16, R. 23, shipped a large portion of this output. The other 1912 shippers were the Keys Mining Co. and the Spanish Lemarr Mining Co. The ore was mined from depths of 40 to 70 feet and was shipped without treatment of any kind.

Sevier County.—The old Bellah mine at Gillham, owned by Tyler & Hippach, was under bond in 1912 to Sober & Co., and some development work was done early in the year. There is a mill on the property, but no concentrates were sold. The Sober lease has since been forfeited and the owners have leased the mine to the United Zinc Cos.

ILLINOIS.

By J. P. Dunlop.

PRODUCTION.

The production of lead, zinc, and silver in Illinois in 1912 is shown in the following tables:

Production of lead and zinc in Illinois, in 1912, in short tons.[a]

District.	Ores.				Metal content.			
	Lead concentrates, galena.		Zinc concentrates, sphalerite.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Northern Illinois (Galena)	864	$47,847	13,464	$367,537	687	$61,830	4,065	$560,970
Southern Illinois	797	38,650	.....	.....	595	53,550	.....	.....
State total	1,661	86,497	13,464	367,537	1,282	115,380	4,065	560,970
State total, 1911	1,269	62,425	11,011	320,806	964	86,760	4,219	480,966

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Production of silver in southern Illinois, 1909–1912.

Year.	Silver.		Lead concentrates, silver-bearing.	
	Quantity.	Value.	Quantity.	Ounces of silver per ton.
	Fine ozs.		*Short tons.*	
1909	1,011	$526	259	3.903
1910	2,022	1,092	398	5.08
1911	3,036	1,609	482	6.25
1912	4,731	2,909	748	6.31

Tenor of lead and zinc ore and concentrates produced in Illinois, 1911 and 1912.

	1911	1912
NORTHERN ILLINOIS.		
Total crude ore, short tons	153,313	147,859
Total concentrates in crude ore:		
Lead, per cent	0.6	0.6
Zinc, do	7.2	9.1
Metal content of crude ore:		
Lead, do	.4	.4
Zinc, do	3.2	3.2
Average lead content of galena concentrates, do	79.4	79.5
Average zinc content of sphalerite concentrates, do	45.3	35.4
Average value per ton:		
Galena concentrates	$52.37	$55.38
Sphalerite concentrates	$29.13	$27.30
SOUTHERN ILLINOIS.		
Average lead content of galena concentrates, per cent	70.0	74.6
Average value per ton of galena concentrates	$44.00	$46.49

The lead concentrates produced in southern Illinois are recovered in concentrating the fluorspar. To speak of the total crude ore raised as crude-lead ore, would be misleading. No attempt has been made, therefore, at calculating the tenor of the crude ore.

The value of the mine production of silver, lead, and zinc in Illinois in 1912 was $679,259, an increase of $109,924, or about 20 per cent, over the output for 1911. The lead concentrate produced amounted to 1,661 short tons, which was 392 tons more than in 1911, and the metal content increased from 964 tons in 1911 to 1,282 tons in 1912.

The zinc concentrate increased from 11,011 short tons in 1911 to 13,464 tons in 1912, and the recoverable zinc content of the concentrate decreased from 4,219 tons in 1911 to 4,065 tons in 1912, although on account of the higher price of zinc in 1912 the value was $79,996 more in 1912 than in 1911.

The silver recovered from lead concentrates smelted amounted to 4,731 fine ounces, valued at $2,909, against 3,036 fine ounces, valued at $1,609, in 1911.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineralogical association and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwest county of the State. The ores have the same structural relations as in the upper Mississippi district generally; that is, they occur disseminated through the limestone, or in openings in it called "crevices," "pitches," or "flats," depending on their attitude to the horizontal. These openings have, in general, an east and west trend, known as their "range." The ore bodies are sometimes continuous for long distances along these "ranges," which for that reason largely control the prospecting, both by shafts and by drilling. The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite, and smithsonite, though the latter is much less common now than formerly, when the deposits worked were mostly shallow and above water level. The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Iron pyrite is very commonly associated with the ores, frequently in such quantity as to necessitate roasting and magnetic separation. Some of the concentrating plants have calciners or roasters and magnetic separators attached, and there is a custom roaster and separator operated by the Joplin Separator Co., at Galena, Ill. There were also separating plants operated near by in Wisconsin by the Campbell Magnetic Separating Co., at Cuba City; the National Zinc Separating Co., at Hazel Green; and the Wisconsin Separating Co., at Benton.

As none of the operators in the Elizabeth and Sand Prairie districts reported any production in 1912, the entire output of northern Illinois was from the Galena district. The production of lead concentrates was 864 tons, valued at $47,847, as compared with 787 tons, valued at $41,220, in 1911.

There were 13,464 tons of zinc concentrates, valued at $367,537, produced in 1912, an increase of 2,353 tons in quantity and of $46,731 in value compared with the output in 1911. The average price per ton received for sphalerite concentrates was $1.83 less than in 1911.

The tonnage of crude ore mined decreased from 153,313 tons in 1911 to 147,859 tons in 1912. The zinc concentrates in the ore milled showed an increase of 1.9 per cent, while that of lead was the same as it was in 1911.

The average zinc content of the sphalerite concentrate declined about 10 per cent, it being 45.3 per cent in 1911 and 35.4 per cent in 1912.

REVIEW BY DISTRICTS.

Elizabeth and Sand Prairie districts.—Neither of these districts reported any production of lead or zinc in 1912, and no development work of any consequence was accomplished.

Galena district.—The Galena district includes the mines in the vicinity of Fever River from Mississippi River to the Wisconsin State line. For many years the principal production was of lead ores, but in recent years the principal output has been zinc ores. The production of galena concentrates, however, has increased from 126 tons in 1910 to 864 tons in 1912. Over 70 per cent of the zinc

concentrates shipped from the district in 1912 were produced by the Vinegar Hill Zinc Co. from the Vinegar Hill and Unity mines, the first-named mine yielding about one-half the total zinc concentrates of the district in addition to a good production of galena concentrates. Both the Unity and the Vinegar Hill mines are equipped with a 100-ton concentrating plant, operated with electric power from the Interstate Light & Power Co. The Vinegar Hill Zinc Co. did some development work on the Lake Superior and Hughlett & Gray mines, but made no output of concentrates.

The Northwestern Zinc Co. made extensive additions to the equipment at their mine and 100-ton concentrating plant and sold a large quantity of low-grade green sphalerite concentrates to the separating companies. The production of galena concentrates was also quite large.

The Ten Strike Consolidated Mining Co. operated the Merry Widow, Ten Strike, and White Rose mines, and in 1912, as in 1911, was the largest producer of lead ore in the Galena district, and in addition produced a good output of sphalerite. Most of the output was derived from the Merry Widow mine, which is equipped with a 100-ton concentrating plant. The Ten Strike mine is equipped with a smaller plant. The shaft on the Ten Strike is 153 feet deep and that on the Merry Widow 126 feet deep. The White Rose mine shaft is only 71 feet deep. Churn drilling ahead of the drifts disclosed good ore bodies in both the White Rose and the Merry Widow mines.

There was no output from the old Pilot Knob mine, now owned by the Glen Ridge Mining Co., but the mine was actively developed and a 100-ton plant was completed in December. The Pilot Knob mine is near the old Black Jack mine, which was bought late in 1912 by the Mineral Point Zinc Co. The same company purchased the Ryan land and were engaged in thoroughly prospecting both properties.

The Weinschenk mine, which has been a small producer of galena for many years, was purchased by the Indianapolis Lead & Zinc Co. The more extensive operations of these old mines and of the new prospects by well-known mining companies should result in an increased production from the district in 1913.

SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of lower Carboniferous age, in the northern extension of the Kentucky-Illinois fluorspar district. The structural relations and the mineralogic association are similar to those of the deposits of western Kentucky and in striking contrast to those of the deposits of northern Illinois. The ores occur in fissure veins, in association with jointing and faulting. The mines have been worked to depths of 300 and 500 feet without disclosing any decrease in the dimensions of the ore bodies. Dikes and sheets of lamprophyre and dikes of mica peridotite occur in the vicinity, but not in direct connection with the ore deposits. Galena is the most important metallic mineral. Formerly, and nearer the surface, large bodies of galena were worked, but it is at present produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the tonnage of crude ore.

As the district is not reached by railway, the product of the mines is dependent on river transportation.

The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, the silver content ranging up to 12 and 14 fine ounces per ton of lead concentrates, and averaging for the last four years from 4 to 6.31 fine ounces per ton of lead concentrates. The average silver content per ton recovered from lead concentrates in 1912 was 6.31 ounces, and the total quantity recovered was 4,731 ounces. Sphalerite, or zinc blende, is the next important metallic mineral, but it occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last five years. The principal vein minerals are fluorspar, calcite, and barite.

The output of lead concentrates increased 315 tons in quantity, and the silver content recovered in treating the concentrates increased from 3,036 fine ounces in 1911 to 4,731 ounces in 1912. The Fairview and Rosiclare mines were the principal producers in this district.

The Fairview Fluorspar & Lead Co. operates on the Good Hope vein, which was first developed in 1862. The workings are reached by means of four shafts, of which the Good Hope is 503 feet deep; No. 4, 275 feet deep; Blue Diggings, 150 feet deep; and Extension, 165 feet deep. A large part of the lead came from Extension and No. 4 shafts. The Good Hope shaft was operated only on the 475-foot level, and the spar produced but little lead at that depth. No. 4 shaft was operated on the 210-foot and the 275-foot levels. The fluorspar contained considerable lead on the 210-foot level, but much less on the 275-foot level opened up in 1912. Extension shaft was sunk to the 165-foot level during the year and gave indication of the fluorspar carrying considerable lead. The spar hoisted from the old 150-foot Blue Diggings incline shaft contained the average quantity of lead. The new vertical shaft on the Blue Diggings vein was 90 feet deep at the end of 1912. The concentrating plant has a capacity of 250 tons.

The Rosiclare Lead & Fluorspar Co. operates on an ore body which is probably continuous with that of the Fairview. The workings have reached a depth of 300 feet, and the mine has a long record of continuous production. A new steel and concrete mill, entirely fire proof, has been built at Rosiclare, designed to handle 500 tons a day and provided with special facilities for saving the lead and zinc.

IOWA.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Iowa in 1912 is shown in the following table:

Production of lead and zinc in Iowa in 1908–1912, in short tons.[a]

District.	Ore.						Metal content.			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
	Galena.		Sphalerite.		Carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Dubuque:										
1912	78	$3,900	.....	.....	.....	.....	63	$5,670	.....	.....
1911	75	3,750	.....	.....	.....	.....	60	5,400	.....	.....
1910	25	1,320	245	$5,740	.....	.....	20	1,760	96	$10,368
1909	45	2,079	.....	.....	100	$1,500	36	3,096	35	3,780
1908	63	3,613	829	23,183	.....	.....	51	4,284	395	37,130

[a] In calculating the metal content of the ore from assays, allowance has been made for smelting losses in the case of zinc, but not in the case of lead. In comparing the value of ore and metal content it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

It is not deemed advisable to publish figures of the total crude-ore production of Iowa for 1910, 1911, or 1912. The production of sphalerite concentrates in 1910 was practically all from the Avenue Top mine. The output of other concentrates was made up of small lots obtained as the result of development work, and these are not a fair clue to the average ore tenor. As noted below, the ores occur under much the same condition as in Wisconsin, and the averages reached for that State would hold reasonably well for Iowa.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles in Dubuque, Clayton, and Allamakee counties. They are found in the Galena dolomite, of Ordovician age. In early days the Dubuque mines were the most important source of lead in the United States, and in later years the mines, especially those in the vicinity of Durango, yielded considerable quantities of zinc carbonate ore. Nearly all this earlier mining was done above water level, and only within the last few years has there been much attempt to mine below water level. Therefore the production, particularly of zinc-blende ore for these years, though small, is noteworthy, since it represents the attempt to mine at deeper levels.

The ore deposits of the Dubuque district occur in crevices and in caves or "openings" along these crevices. Of these openings there are five or six, the "top," "middle," and "third" being the most prolific of ore. The "flats" and "pitches" common in the Wisconsin mines have been found in only one or two instances in Iowa. The crevices have an east-west trend, and sometimes extend considerable distances, being mined at different places, in which case they are

known as "ranges." The mining operations of recent years have generally been confined to attempts to find paying ore at deeper levels in these old ranges which are known to have yielded ore in former days in the upper openings.

The only production of lead in the Dubuque district in 1912 was 78 short tons of lead concentrates, sold in small lots. No sales of sphalerite concentrates were reported. The Aguanico Mines Development Co. (formerly the Avenue Top), in the western part of Dubuque, did not operate either the workings or the 100-ton concentrating plant. The Bellman, Bray, Fitzpatrick, Big Joe, Byrne & Saul, Grand View, Harriman, Lore, and Peacock mines were idle the entire year.

The Gooschorn mine has no concentrating plant and is worked from the 192-foot level. One shaft is down 192 feet and another 160 feet, and electric power is used for hoisting. Little work was done in 1912 pending the erection of a concentrating plant.

Most of the lead ore came from prospects operated by means of shallow shafts, the miners being paid a certain daily wage and a portion of the selling price of the lead recovered. Many of the large companies ceased operating and surrendered their charters. Some lead will continue to come from the small mines, but the present outlook is not favorable for any large output of zinc from the deep workings.

KANSAS.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Kansas in 1912 is shown in the following table:

Production of lead and zinc in Kansas in 1912, by districts, in short tons.[a]

District.	Ores.								Metal content.			
	Lead concentrates.				Zinc concentrates.				Lead.		Zinc.	
	Galena.		Carbonate.		Sphalerite.		Carbonate and silicate.		Quantity.	Value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value	Quantity.	Value.	Quantity.	Value.				
Badger-Peacock and Lawton...	166	$8,502	.....	.....	2,094	$102,847	.....	.....	130	$11,700	1,120	$154,560
Galena.....	2,837	150,296	33	$1,335	19,164	902,662	125	$3,152	2,241	201,690	9,513	1,312,794
State total:												
1912.....	3,003	158,798	33	1,335	21,258	1,005,509	125	3,152	2,371	213,390	10,633	1,467,354
1911.....	3,621	197,852	.....	.....	20,287	734,148	122	2,916	2,859	257,310	10,272	1,171,008

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

[b] It is necessary to combine the production of the Badger-Peacock and the Lawton districts to avoid disclosing indivdiual returns.

Tenor of lead and zinc ore and concentrates produced in Kansas, 1911 and 1912.

	1911	1912
Total crude ore.....short tons..	761,465	744,254
Total concentrates in crude ore:		
Lead.....per cent..	0.5	0.4
Zinc.....do....	2.7	2.8
Metal content of crude ore:		
Lead.....do....	0.4	0.3
Zinc.....do....	1.5	1.6
Average lead content of galena concentrate.....do....	78.9	78.3
Average lead content of lead carbonate concentrates.....do....	.....	54.5
Average zinc content of sphalerite concentrates.....do....	56.0	55.4
Average zinc content of zinc silicate and carbonate.....do....	38.5	39.2
Average value per ton:		
Galena concentrates	$54.64	$52.88
Lead carbonate concentrates	.....	40.45
Sphalerite concentrates	36.19	47.30
Zinc silicate and carbonate	23.90	25.30

The lead and zinc deposits of Kansas, so far as developed, are limited to the southeastern portion of the State, in Cherokee County. They comprise the western extension of the ore deposits of the Joplin region and display the general characteristics of that area, except that here typical sheet-ground deposits have not been extensively developed. The ores are galena and lead carbonate, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, carrying but a small fraction of an ounce of silver to the ton of lead concentrates.

The value of the mine production of lead and zinc in Kansas in 1912 was $1,680,744, as compared with $1,428,318 in 1911. The increase was due in part to the higher value of spelter, and in part to an increased output of sphalerite in the Galena district and of both galena and sphalerite in the Lawton district.

The production of galena concentrates decreased from 3,621 short tons, valued at $197,852, in 1911 to 3,003 tons, valued at $158,798, in 1912. The lead carbonate produced amounted to 33 tons, valued at $1,335. The lead content of the galena and lead carbonate concentrates was 2,371 tons, valued at $213,390. The percentage of lead in the crude ore milled decreased from 0.5 per cent in 1911 to 0.4 per cent in 1912 (which per cent was the same as in the year 1910). The average lead content of the galena concentrates and the average price received by the producers were slightly less in 1912 than in 1911. The decreased portion of galena concentrates in comparison with the sphalerite concentrates seems to have been due to a lessened output of galena recovered from mines in blanket ground, for while the sphalerite concentrates from mines of this character increased the galena concentrates recovered showed a decline in output.

The production of zinc carbonate and silicate amounted to 125 tons, valued at $3,152, which was 3 tons more in quantity than in 1911. The production of sphalerite concentrates in 1912 was 21,258 tons, valued at $1,005,509, which was an increase of 1,394 tons in quantity and of $271,361 in value. It is of interest to note that although the production of sphalerite in 1912 was about 7,000 tons less than in 1910, the value was more than $7,000 greater.

The average zinc content of the sphalerite shipped in 1912 was 0.6 per cent less than in 1911, but the average price received per ton

was $11.11 more than in 1911. The quantity of crude ore treated and the average recovery of concentrates from the ore was about the same in 1912 as in 1911.

There were many transfers of mining leases and an infusion of new capital at both Galena and Lawton. The Murphy flume in the Short Creek bottoms, which was destroyed in 1911, was reconstructed, but not until many of the mines had remained flooded for over six months of the year.

Galena and Lawton districts were active, but little work was done in the Badger-Peacock district and nothing whatever in the Playter camp. Some drilling was done in new territory near Blue Mound just north of the State line between Oklahoma and Kansas. The westward extension of the Galena district appears probable, for drilling is stated to have disclosed lead and zinc ore.

Badger-Peacock district.—On account of the necessity of combining the 1912 production of the Badger-Peacock and the Lawton districts in order to avoid disclosing the output of a single producer at Lawton the exact decrease in the Badger-Peacock district can not be given, but roughly stated the value of the lead was only 25 per cent and the value of the zinc 17 per cent of the 1911 production. Two reasons for the decreased output in this district were the flooding of the mines of the largest producing companies in the spring of the year and the destruction by fire of the large mill of the S. H. & S. Mining Co.

The production of concentrates from ore hoisted in 1912 was from the Badger and S. H. & S. mines and was made prior to April. The only producing property on the land of the Middlesex Land & Mining Co. was the Badger. The old lease to the company of that name was forfeited and 51 acres of the land was re-leased to J. B. Meredith, who operated the 100-ton concentrating plant on tailings. The two shafts which are 140 feet deep were flooded nearly the entire year.

The S. H. & S. mill on the United Zinc Co. land was burned after being operated for part of the month of January, 1912. The underground workings gradually filled with water and the property has since been idle. The Spring River plant of the Peacock Valley Mining Co. is the only mill now remaining on United Zinc Co. land. The Thomas D. lease of the Federated Zinc Co. was forfeited and the concentrating plant was removed.

The T. R. Lynas land was developed in the latter part of 1912; 2 shafts were sunk 100 feet to the ore body, and a 200-ton electrically driven concentrating plant was finished in December. The 1912 output was small.

Lawton district.—This district is situated 3½ miles north of Badger-Peacock and 14 miles northwest of Joplin and was first prospected about 1900. It remained dormant until the latter part of 1910, when the Eastern Lead & Zinc Co. leased a large acreage, prospected its leasehold by means of churn drills, and sunk a shaft. The quantity of water encountered in the shaft required the installation of pumps of large capacity and delayed production. The 200-ton electrically equipped concentrating plant turned out its first concentrates in June, 1911, and the production was good for the last months of the year. In 1912 the mill was operated steadily, and the output was more than double that for the year 1911. Two shafts, one 100 feet deep and the other 145 feet deep, were in use. The company continued to drill its large land holdings, and many new leases were

granted. No production was made by any of the lessees in 1912, but development work accomplished will probably result in two new concentrating plants being built, which will greatly increase the output of the district.

The Pluto Mining Co. sunk a shaft on the Sam Williams land and ran some drifts on the 53-foot level.

Galena district.—The production of lead concentrates in the Galena district was 2,870 tons, as compared with 3,487 tons in 1911. The shipment of zinc concentrates (all of which was sphalerite except 125 tons) was 19,289 tons, an increase of 1,397 tons.

Owing to the higher prices paid for the increased output in 1912, the total value of the zinc concentrates was $261,476 more than it was in 1911.

The Diplomat mine on the Galena Lead & Zinc Co.'s land was the largest single producer of both lead and zinc concentrates in Kansas in 1912. The ore lies in a sheet formation, and in 1911 yielded, when milled, about 2.6 per cent of concentrates in about the proportion of 4 of sphalerite to 3 of galena. The face of the ore is about 10 feet high. There was an increase of about 50 per cent in the quantity of ore milled in 1912, but the average recovery of concentrates was less and the proportion of galena concentrates recovered from the crude ore was appreciably less than in 1911. There are three 100-foot shafts, two of which were used exclusively to hoist the dirt. The concentrating plant has a capacity of 200 tons (per 10-hour shift) and frequently treated over 500 tons of crude ore a day. The mill, hoists, drills, and other machinery were operated by electric power.

The Lockport Mining Co.'s leases on the Arthur, Brinkerhoff, Cooper, Hoosier, and Windsor lands were not as large as in previous years. Most of the output from these leases came from the Mess, Galena, Open Cut, and Phillips subleases on the Windsor land. Both the Mess and the Galena open-cut mines are equipped with concentrating plants. The Hartford Mining Co.'s production from the Sexton land increased considerably over that for 1911. The mine on this property has 2 shafts 168 feet deep and has a large concentrating mill. This plant and all mining machinery were fully equipped with electric motors. Some of the ground mined in 1912 proved very rich, and 6 drill holes put down on the lease are reported to have been in good ore.

The Illinois Lead & Zinc Co.'s land was a large producer of sphalerite concentrates, but the ore carries very little galena. The Peacock-Galena and the Bloomington mines were the largest producers on this lease. The Peacock-Galena shaft was down about 80 feet and the mill of 150 tons capacity was operated by electric power.

The old Southside tract leased to Franklyn Playter was more actively worked than it has been in recent years, and the value of the output by the lessees was only exceeded by that of the Diplomat mine. The depth of mining ranged from shallow gouges to 140 feet deep, and about 25 shafts were used to hoist ore. The production was mainly made by small operators, the ore being treated at the two custom mills on the lease or sold in the rough at a flat rate per ton. Development was more satisfactory than for many years, new productive levels being opened at 135 feet and 140 feet on the north side of the tract.

The Latawanna land made its usual output. Ten shafts were operated part of the year by various lessees, and the ore was milled at the Edith T. Mining Co. mill of 150 tons capacity. The principal producer on the Murphy Mining & Realty Co. land was E. H. Stearns, who operated a tailing mill for a portion of the year. Other producing leases were the Gussie Moore (old Elinita), West Empire, and Phelps & Co. Three shafts ranging in depth from 15 to 70 feet on the Empire Mining Co.'s lease to James Murphy were working part of 1912.

The Clermont Mining & Milling Co.'s production was not as large in 1912 as it was in 1911. This mine is in sheet ground and is operated by means of a 161-foot shaft. The mill at the property is of 150-ton capacity and the recovery of concentrates from ore treated is high for "sheet ground."

The Pilsener Mining Co. was a good producer for a part of the year, but had financial difficulties and went into the hands of a receiver.

The Prudential and Riddle tracts, which were under lease to the Harmon Mining Co. and operated by them for several months, were transferred to Ball & Gunning, who subleased to Chapman & Lennan. The property was actively developed by the sublessees, the 150-ton mill was remodeled, and a fair output was made during the last three months of the year. The 6 shafts on the property range from 75 feet to 100 feet in depth.

The producing leases on the Cornwall and the Buckhorn lands of the Playter Mining Co. were the Amboy and the Monte Cristo. A large portion of the ore was sold in the rough, there being no mill on the property.

Scott & Quigg, lessees on the Templar Mining Co.'s land, produced some very rich "dirt" taken from three shafts 60 to 80 feet deep. This ore was milled at a custom concentrating plant.

The Black Hills mine and mill on the Mid Summer Mining Co.'s land was taken over by F. L. Stone, who produced ore from 3 shafts and also milled some custom ore.

Four shafts were operated on the land of the Glick Land & Mining Co. A new 60-ton concentrating plant, called the Scarlet Kid mill, was erected by F. S. Cook, one of the lessees.

The producing leases on the Connor land were W. W. P. Clements, the Monte Cristo Co., and the Dunnegan Mining Co.

There was a large quantity of rough ore sold by various lessees in 1912. Much of this ore was purchased by C. W. Squire, G. C. Monlux, McKinney & Co., and Sterling Robinson. The mills operated by these ore buyers produced a large portion of the blende concentrates shipped from the district.

Other producers of either lead or zinc concentrates in 1912 were lessees of the Boston Land & Mining Co., J. Pollard, Bonanza Lead & Zinc Co., Electric Light Plant Mining Co., Rohrbaugh Bros., High Life Mining Co., B. Cooley, Owl Milling Co., Stone Mercantile Mining & Manufacturing Co., W. F. Sapp, J. K. Williams, and the Wyandotte Lead & Zinc Co.

KENTUCKY.

By J. P. Dunlop.

PRODUCTION.

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in Franklin, Mercer, Scott, Owen, or Henry counties, in the central districts reported any lead or zinc concentrates shipped in 1912. The mines in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of the southern Illinois lead and zinc region. Considerable quantities of galena ores have been produced in former years, but at the present time lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content varying from a very small quantity to over 3 ounces per ton, but no recovery of this silver content has been reported by the smelters during the last two years. The lead concentrates shipped in any one year from Kentucky do not necessarily represent the actual recovery of lead from fluorspar mined in that year, for being merely accessory to the fluorspar and produced in small quantities, it is frequently held until a considerable quantity has accumulated or until lead prices are high.

No shipments of galena concentrates were reported in 1911, but 151 tons valued at $6,827 and having an average lead content of 70.2 per cent were shipped to smelters in 1912. The recoverable metallic content of the galena concentrates was valued at $9,540.

The quantity of zinc concentrates shipped increased from 467 short tons in 1911 to 1,243 short tons in 1912, and the total value increased from $10,604 to $41,391. The zinc concentrates sold comprised 493 tons of sphalerite of good grade and 750 tons of zinc carbonate averaging 35.6 per cent metal content. The estimated recoverable spelter content was 491 tons, valued at $67,758, a large increase over the 1911 output, which was 158 tons, valued at $18,012.

The largest producer of galena concentrates in 1912 was the Kentucky Fluorspar Co., at Marion. The Roberts Fluorspar & Lead Co. operated two shafts on the Keystone land, one of which was 298 feet and the other 210 feet in depth. A good production of galena was separated from the fluorspar and sold. Other shippers of galena were the Eagle Fluorspar Co. and the Larue Co.

The Eclipse Mining Co. operated the Commodore mine in the Marion district and succeeded in milling ore derived from the 185-foot level. The concentrating plant contains three jigs and a slime table and has a capacity of about 50 tons per 10-hour shift. Some difficulty was encountered at first in making a good separation of the sphalerite from the fluorspar in an old mill of inadequate capacity. The average recovery of concentrates from ore was approximately 10 per cent and the average zinc content of the concentrates was increased from 54.4 per cent in early operations to over 59 per cent. All the sphalerite concentrates shipped from Kentucky in 1912 were derived from the Commodore mine.

The largest shipper of zinc carbonate concentrates was the Langenbach Mining Co., operating the Mann mine near Lola. Two shafts about 128 feet deep were utilized to obtain the ore.

The Sanders Ore Separating Co. worked the land of the Marion Mineral Co. and shipped a good output of zinc carbonate of high grade.

The Ohio Valley Mining Co. was developing the Blue & Marble property near Mexico. No shipments were made, but some zinc carbonate was hoisted and placed on the dump.

The Crittenden Springs mine, 6 miles northwest of Marion, was worked by E. F. W. Kaiser, but had not reached the producing stage.

The Hoosier Mining Co., at the old Tabb mine, sold no zinc concentrates in 1912. Some fluorspar was shipped but mostly development work was done, including the sinking of a new shaft and the installing of new boilers and pumps.

MICHIGAN.

By B. S. Butler.

PRODUCTION.

In 1912 the mines of Michigan produced 218,138,408 pounds of copper, valued at $35,992,837, and 528,453 ounces fine of silver, valued at $324,999, a total value in copper and silver of $36,317,836. This is an increase of $8,574,264 in value, or about 30 per cent over the production of 1911. The increase in the value of the mineral output was due to the increase in the price of copper, as there was a slight falling off in the output of that metal. There was an increase in both the quantity and the value of the silver production. For 1911 the average price of copper per pound was $0.125, and for 1912 it was $0.165. The average price of silver for 1911 was $0.53 per fine ounce, and for 1912 it was $0.615. Owing to the increase in the price of copper there was an increase from $2.50 in 1911 to $3.15 in 1912 in the average value per ton of rock treated.

The smelter production, or the output of refined copper, for 1912 was 231,112,228 pounds as compared with 218,185,236 pounds in 1911. The difference between the mine and the smelter production is due to the fact that the quantity of mineral produced is not the same as the quantity smelted. A company may produce either more or less mineral than it smelts during the year.

The following table shows the average values in copper and silver of rock treated in 1911 and 1912:

Value of silver and copper product of Michigan mines in 1911 and 1912.

Year.	Silver.	Copper.		Combined silver and copper, total value.
		Value.	Value per ton of rock.	
1911	$263,559	$27,480,013	$2.50	$27,743,572
1912	324,999	35,992,837	3.15	36,317,836
Increase	61,440	8,512,824	.65	8,574,264

The entire Michigan output of copper and silver is from the Keweenaw district. Both metals occur native in lodes remarkable for their great extent and uniformity. These lodes may be divided into two

general classes: The amygdaloid, in which the metals occur together with gangue minerals, epidote, calcite, zeolites, etc., in the cellular portions of lava flows, and the conglomerate, in which the metals and gangue minerals cement and to some extent replace the pebbles forming the conglomerate. Native copper and copper minerals occur in fissures in the district, but at the present time the output from this type of deposit is of little importance. The "rock" [1] is of low grade and requires milling, which produces "mineral" carrying an average of about 65 per cent copper. A small quantity of "barrel" and "mass" copper is sorted at the mines and sent direct to the smelters.

In 1912 there were 11,411,941 short tons of rock milled, which yielded 339,756,812 pounds of "mineral" and 218,138,408 pounds of copper.[2]

The average recovery of refined copper per ton of rock milled in 1912 was 19.1 pounds, as compared with 20 pounds in 1911.

There were 528,453 ounces of silver derived from the electrolytic treatment of 45,570,130 pounds of copper. This electrolytic copper was recovered from approximately 2,500,000 tons of rock, an average of 0.211 fine ounce of silver per ton of rock.

The following table shows the production of metal, "mineral," and "rock" in Michigan for 1911 and 1912:

Production of silver, copper, "mineral," and "rock" in Michigan in 1911 and 1912.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of rock.		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1911	497,281	219,840,201	20.0	1.00	338,908,309	64.86	10,978,827
1912	528,453	218,138,408	19.1	0.96	339,756,812	64.24	11,411,941
Increase (+) or decrease (−)	+31,172	−1,701,793	−0.9	−0.04	+848,503	−0.62	+433,114

The following table shows the relative productive importance of the amygdaloid and the conglomerate rock in 1911 and 1912. As in previous years, the most significant fact brought out is the continued decrease in the copper derived from conglomerate. The relative proportion of conglomerate "rock" milled as compared with amygdaloid "rock" showed a slight decrease in 1912 from 1911. The proportion of copper derived from conglomerate dropped from 31.4 per cent in 1910 to 30 per cent in 1911 and to 27.3 per cent in 1912. The yield per ton of conglomerate "rock" was 28.3 pounds in 1910, 28.4 pounds in 1911, and 27.7 pounds in 1912.

In 1907 conglomerate "rock" produced 41.4 per cent of the output, with a yield of 33.9 pounds per ton.

In 1912 amygdaloid "rock" yielded 17.1 pounds of copper per ton, as compared with 17.7 pounds per ton in 1911.

[1] Some of the terms used to designate the different materials entering into the mining industry differ for the Lake district from those employed in any other part of the country. Ore is known as "rock" or "copper ground" (if unmined); the product of concentration is known as "mineral;" the term "ore" is used to designate the copper minerals (arsenides, sulphides, etc.) that occur to a limited extent in the district. Large bodies of native copper are known as "mass," and smaller ones are designated as "barrel work." In this report the local terms will be used, as it does not seem desirable to employ the more usual terms to the exclusion of the local, while a mixture of the two is confusing.

[2] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during 1912.

Production of "rock" and "mineral" and yield in silver and copper in Michigan in 1911 and 1912, by kinds of rock.

	1911		1912	
	Amygdaloid "rock."	Conglomerate "rock."	Amygdaloid "rock."	Conglomerate "rock."
Silver:				
Fine ounces	497,281		528,453	
Average yield per short ton of rock..ounce..	0.4		0.05	
Copper:				
Pounds	153,876,626	65,963,476	158,553,428	59,584,980
Per cent of total	70.0	30.0	72.7	27.3
Average yield per short ton of rock..pounds..	17.7	28.4	17.1	27.7
Average yield..per cent..	0.85	1.42	0.85	1.38
"Mineral":				
Pounds	224,308,354	114,599,955	235,026,944	104,729,868
Per cent of total	66.2	33.8	69.1	30.9
Average yield in copper..per cent..	68.6	57.3	67.5	56.9
"Rock":				
Short tons	8,662,005	2,316,822	9,264,816	2,147,125
Per cent of total	79.7	20.3	81.2	18.8

Three counties, Houghton, Keweenaw, and Ontonagon, contributed to the output of copper and silver in 1912. The following table shows the relative importance of these counties in output of copper and silver for 1911 and 1912. It may be noted that the increase in silver is not due to a marked increase in the silver content of the "rock," but that more copper was treated electrolytically in 1912 than in 1911. Houghton County shows a slight decrease in the recovery of copper per ton of "rock," owing to the continued decrease in the conglomerate rock. The recovery for Keweenaw County was higher than in 1911, while that of Ontonagon County showed a decrease. The recovery for the entire district was slightly lower than in 1911; for 1912 it was 19.1 pounds per ton, or 0.96 per cent.

Production of silver and copper in Michigan for 1911 and 1912, by counties.

1911.

County.	Silver.	Copper.		"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."	Quantity.	Yield.	
	Fine oz.	*Pounds.*	*Pounds.* *Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
Houghton	459,715	184,572,400	20.3 1.02	289,204,888	63.8	9,072,210
Keweenaw	37,053	32,079,885	18.8 .94	45,225,456	70.9	1,704,048
Ontonagon	513	3,187,817	15.7 .78	4,477,965	71.2	202,569
Total	497,281	219,840,201		338,908,309		10,978,827
Average			20.0 1.00		64.8	

1912.

Houghton	475,453	179,476,295	19.6 0.98	284,218,905	63.1	9,145,601
Keweenaw	53,000	33,976,822	19.2 .96	48,633,935	69.9	1,772,817
Ontonagon		4,685,291	9.5 .47	6,903,972	67.9	493,523
Total	528,453	218,138,408		339,756,812		11,411,941
Average			19.1 .96		64.2	

REVIEW BY COUNTIES.[1]

In the following reviews of the operations at the individual mines of the district during 1912 the statements concerning the quantity, character, and tenor of "rock" developed, the quantity of rock stamped, the copper recovered per short ton of rock stamped, and the cost of production are based on the published reports of the companies. In the few cases in which reports are not published a general statement of the character of operations is made from the best information available.

HOUGHTON COUNTY.

In 1912 the mines of Houghton County produced 179,476,295 pounds of copper and 475,453 ounces of silver, or 82.2 per cent of the copper and 89.9 per cent of the silver output of Michigan. The county occupies the central portion of the copper belt and contains 15 of the 22 mines that contributed in 1912 to the copper output and 6 of the 8 mines that produced silver.

The details of the production in 1911 and 1912 are shown in the following table:

Production of "rock" and "mineral" and average yield in silver and copper in Houghton County in 1911 and 1912, by kinds of rock.

	Amygdaloid rock.		Conglomerate rock.		Total and average.	
	1911	1912	1911	1912	1911	1912
Silver:						
Fine ounces	[a] 459,715	[a] 475,453	.....	.....	459,715	475,453
Copper:						
Pounds	118,608,924	119,891,315	65,963,476	59,584,980	184,572,400	179,476,295
Per cent, county total	64.3	66.8	35.7	33.2	100.0	100.0
Average yield per ton of rock in pounds	17.5	15.9	28.4	27.8	20.3	19.6
Average yield...per cent	0.87	0.79	1.42	1.39	1.02	0.98
"Mineral":						
Pounds	174,604,933	179,489,037	114,599,955	104,729,868	289,204,888	284,218,905
Average yield...per cent	67.9	66.8	57.3	56.9	63.8	63.1
"Rock":						
Short tons	6,755,388	6,998,476	2,316,822	2,147,125	9,072,210	9,145,601
Per cent, county total	74.5	76.5	25.5	23.5	100.0	100.0

[a] Silver from conglomerate and from amygdaloid rock has not been separated. A large percentage, however, was derived from amygdaloid rock.

The county shows a decrease of 5,096,105 pounds of copper and an increase of 15,738 fine ounces of silver for 1912. This increase in silver, as already stated, is due to an increase in the quantity of copper that was refined electrolytically rather than to any marked change in silver content of the "rock."

Calumet & Hecla.—The Calumet & Hecla mine has been one of the most successful copper mines in the world. In the yield of copper and dividends paid it ranks first among the copper mines of the country. To the close of 1912 the company had distributed $120,050,000 in dividends.

[1] Those desiring more details concerning individual properties are referred to a report by Reginald E. Hore, Mineral resources of Michigan, Michigan Geol. and Biol. Survey, 1911, pp. 15–115. This report contains a description of the geology, ore deposits, methods of extraction, and treatment of ores, of developments at individual properties, of cost of production, etc., and gives references to the more important publications concerning the copper industry of the district.

The company's ground contains three copper-bearing lodes, the "Calumet" conglomerate, the Osceola amygdaloid, and the "Kearsarge" amygdaloid. A large percentage of the production in the past has come from the conglomerate lode, but with the decrease in copper content of this lode and its approaching exhaustion the mining from the amygdaloid lodes has increased.

The company's annual report shows the details of operation for 1912 as follows:

During 1912 there were 2,806,610 short tons of rock stamped, yielding 67,856,429 pounds of copper, or an average of 24.18 pounds of copper per ton of "rock." This compares with a yield of 25.47 pounds for 1911 and of 25.77 pounds for 1910. The total cost per pound of copper was 9.86 cents for 1912, as compared with 8.52 cents for 1911 and with 8.96 cents for 1910.

The conglomerate is opened for a distance of nearly two miles along its strike by 10 inclined shafts and one vertical shaft. The inclined shafts vary in depth on the dip of the lode from 6,102 to nearly 8,000 feet. The Red Jacket vertical shaft has a depth of 4,900 feet. The lode in the "Five Forties" tract, extending north from the company's main holdings, is developed by a slope shaft from the fifty-seventh level. The rock from this shaft is hoisted to the surface through the Red Jacket shaft.

In 1912 the conglomerate lode produced 1,746,960 tons of "rock," yielding 51,935,245 pounds of copper, or an average of 29.73 pounds per ton of rock. This compares with 30.12 pounds for 1910 and with 30.38 pounds for 1911.

The cost of producing copper from the conglomerate lode in 1912 was 8.87 cents per pound, as compared with 8.25 cents in 1911 and with 8.55 cents in 1910.

The Osceola lode is developed by six shafts varying in depth from 1,460 to 3,812 feet. The lode has an average width of from 30 to 35 feet, though at some points it is much wider. The mineralization is confined principally to the hanging and the foot walls. The lode is opened by drift stopes along the hanging wall, where the mineralization is rather uniform. Crosscuts are extended to the footwall, where the mineralization is far less regular. During 1912 this lode produced 1,040,600 tons of "rock," yielding 15,692,199 pounds of copper, or 15.08 pounds per ton of "rock." This compares with a yield of 15.89 pounds for 1911 and of 15.82 pounds for 1910. The average cost per pound of copper from this lode for 1912 was 10.36 cents, as compared with 9.95 cents for 1911 and with 10.53 cents for 1910.

The Kearsarge lode is opened by three shafts, varying in depth from 1,350 to 2,291 feet. Development on this lode in Calumet and Hecla ground has not been encouraging, though the lode has proved very productive farther north. During the year 1912, 19,050 tons of "rock" from this lode yielded 228,985 pounds of copper.

Tamarack.—The Tamarack ground lies northwest of the Calumet and Hecla and its operations are conducted on the underlays of the "Calumet" conglomerate and the Osceola amygdaloid. Both lodes enter the property at considerable depth and are reached by vertical shafts, the different levels being connected with these shafts by crosscuts. The property is opened by five shafts, varying in depth from 3,409 feet (No. 1) to 5,308.5 feet (No. 5), the latter having the distinction of being the deepest shaft in the world.

The company, although at a disadvantage on account of the great depth of the mine and the consequent high mining costs, has made a good record in dividends, which from 1888 to 1907 aggregated $9,420,000. Since the decline in the price of copper in 1907, however, the company has been unable to show a profit until 1912, when relatively high prices again prevailed and copper was produced at a profit.

The average cost per pound of production during the last three years has been 14.70 cents for 1910, 15.56 cents for 1911, and 13.15 cents for 1912.

Shaft No. 1 is used for handling the water in the southern portion of the mine, thus leaving the neighboring shafts free for the hoisting of ore.

At No. 2 shaft stoping was carried on in both the conglomerate and the Osceola amygdaloid lodes during 1912.

At No. 3 shaft the openings showed rock of fair grade except on the nineteenth and the twentieth levels to the north, where drifting has been discontinued on account of poor showing.

At No. 5 shaft the fortieth level north showed better copper values than any of the higher levels on that side of the shaft.

During the year 421,385 tons of "rock" were stamped, yielding 12,118,038 pounds of "mineral" and 7,908,745 pounds of copper, or 18.8 pounds of refined copper per ton of "rock" stamped. This compares with a yield of 21.1 pounds in 1910 and with 19.1 pounds in 1911.

Osceola.—During 1912 the Osceola Co. operated the three branches—the Osceola, the South Kearsarge, and the North Kearsarge. Since 1878 this company has distributed dividends to the amount of $11,170,100.

The Osceola lies directly south of the Calumet and Hecla and is worked on the Osceola amygdaloid. The property contains the Calumet and Hecla lode, but the only portion of this in Osceola ground that has been shown to carry copper in paying quantities was worked out in the early days of the mine. Production, which had been discontinued on account of the high cost of production and the relatively low price of copper, was resumed at No. 6 shaft on June 1 and in No. 5 shaft on October 1. A total of 115,551 tons of "rock" was produced, yielding 1,479,642 pounds of copper, or an average of 12.8 pounds per ton, at a cost of 14.55 cents per pound.

The North Kearsarge lies north of the Wolverine and is worked on the Kearsarge lode. No. 1 shaft has a depth of 3,873 feet, No. 3 shaft has a depth of 3,251 feet, and No. 4 shaft has a depth of 1,449 feet. A total of 4,452 feet of opening was accomplished on this branch during the year. The openings on the thirty-second level south of No. 1 shaft were poor. The openings at Nos. 3 and 4 shafts were fully up to average. This branch produced 672,231 tons of "rock," yielding 8,611,720 pounds of copper, or an average of 12.8 pounds per ton, at a cost of 11.44 cents per pound.

The South Kearsarge lies south of the Wolverine and east of the Centennial on the Kearsarge lode. No 1 shaft has a depth of 2,820 feet and No. 2 shaft has a depth of 1,992 feet. During the year a total of 431 feet of opening was accomplished. The ground in this branch is practically developed, and at the present rate of production will be worked out in a few years. Fully two-thirds of the tonnage in

1912 was mined from the footwall. This rock consists in part of vein matter which extends back into the footwall and in part of footwall trap, which was found to contain copper. The rock is mined cheaply, and it is hoped that a large part of the old stopes can be worked over in this way. This branch produced 458,651 tons of "rock," yielding 8,322,025 pounds of copper, or an average of 18.15 pounds per ton, at a cost of 6.79 cents per pound.

In 1912 the company stamped 1,246,557 tons of "rock," producing 24,282,312 pounds of "mineral," or 18,413,387 pounds of copper, an average yield of 14.8 pounds of refined copper per ton of "rock." This compares with a yield of 14.8 pounds in 1911 and of 15.9 pounds per ton for 1910. The total cost of refined copper per pound was 10.36 cents for 1912, as compared with 9.28 cents in 1911. The remodeling of the mill was continued through the year.

Centennial.—The Centennial ground lies north of the Calumet and Hecla and west of the South Kearsarge and the Wolverine. It contains the Calumet and Hecla, the Osceola, and the Kearsarge lodes, the last being the only one of proved value in the property, and to this lode operations are at present confined.

At the close of 1912 the depth of No. 1 shaft was 3,821 feet. No work was done in the vicinity of this shaft during 1912. Shaft No. 2 had a depth of 4,158 feet at the close of the year. A total of 2,404 feet of development was accomplished at this shaft. The openings to the north were up to the average quality.

"Rock" to the amount of 106,517 tons was stamped during the year, producing 2,567,385 pounds of "mineral" and 1,742,338 pounds of refined copper, or 16.36 pounds refined copper per ton of rock stamped. The average cost of refined copper per pound was 13.46 cents, as compared with 12.69 cents for 1911.

Wolverine.—The Wolverine is located between the North and the South Kearsarge branches of the Osceola Co. Its operations are on the "Kearsarge" amygdaloid, though the West lode, parallel with the Kearsarge lode and about 80 feet to the west, has been opened to a small extent. The mine has the distinction of having the richest amygdaloid and, next to the "Calumet" conglomerate, the richest rock mined in the district. The Kearsarge lode is opened by four shafts, numbered from 1 to 4, from north to south. No. 1 is abandoned; No. 2, bottomed at the boundary at a depth of 1,700 feet, is used for handling men and supplies; No. 3 is below the thirty-seventh level and can be sunk to a depth of 4,300 feet before reaching the boundary; No. 4 was sunk below the thirty-sixth level during 1911; No. 5 was sunk to a depth of 316 feet on the Osceola lode prior to June, 1912. The operations on the Osceola lode have thus far proved disappointing. The lode in the Wolverine ground shows great uniformity of mineralization and is opened for the full length. In the upper levels the rock averaged from 16 to 18 pounds per ton, but as the lower levels were opened it showed marked improvement, the average for the fiscal year ending June 30, 1912, being 23.45 pounds per ton. The mine has ore blocked out well ahead of stoping requirements and has at the present rate an assured output for some years to come. The crosscut to the east on the twenty-eighth level to explore the footwall of the Kearsarge lode has been extended 1,600 feet from the Kearsarge lode. Several promising lodes were passed through, but "rock" in paying quantity has not yet been developed.

The company's annual report showing the detailed operations in 1912 is not yet available.

During the fiscal year ending June 30, 1912, the mill at Traverse Bay stamped 401,308 tons of "rock," yielding 12,164,780 pounds of "mineral," or 9,408,960 pounds of fine copper, or 23.45 pounds of fine copper per ton of "rock" stamped. The average cost of copper for this period was 7.58 cents per pound.

Franklin.—The Franklin and the Rhode Island, which is controlled by the Franklin, are located southeast of the La Salle. The property carries several lodes, but in the past exploration has been principally on the "Pewabic" amygdaloid and the Allouez or "Albany and Boston" conglomerate. During 1912, operations were confined to the Pewabic lode.

In 1912, a total of 5,134 feet of opening was made, resulting in showing improved ground on the north side of the shaft in the upper levels and on both sides in the lower levels. The improved condition in the two lower levels, the thirty-second and the thirty-third, is especially encouraging. An exploratory crosscut was started east on the thirty-second level to explore the footwall at that depth.

During the year, 176,462 tons of "rock" were stamped, yielding 1,710,651 pounds of copper, or an average of 9.80 pounds per ton of "rock."

Quincy.—The Quincy mine is situated just north of the east-west arm of Portage Lake. The property is traversed by most of the lodes of the district, but has derived its principal output in the past from the Pewabic lode, with a small quantity from the West lode.

The openings for the year amounted to 31,405 feet and 2,734 feet of diamond drilling, developing rock of usual grade. The good showing in the new openings of the bottom of the mine north of No. 8 shaft is worthy of mention.

Dividends from earnings during 1912 to the amount of $605,000 have been paid. The total disbursement of dividends from 1862 to 1912 has been $20,430,000.

During the year 1,309,253 tons of "rock" were stamped at the mills, and 30,040,360 pounds of "mineral" yielded 20,634,800 pounds of refined copper.

Isle Royale.—The Isle Royale mine is situated south of the east-west arm of Portage Lake, near Houghton. The property contains several copper-bearing lodes, of which the Isle Royale is the main producer at present. Development during the year consisted of 941 feet of sinking and 19,106 feet of drifting, drift stoping, and crosscutting. The Isle Royale lode is opened by five shafts, having depths at the close of 1912 as follows: No. 2, 3,162 feet; No. 4, 1,939 feet; No. 5, 1,206 feet; No. 6, 1,553 feet; "A" shaft, 972 feet. At No. 2 shaft the openings were below the average quality of ground for this shaft. On the twenty-ninth level at a point 700 feet north of this shaft, a crosscut was driven to the west and at a distance of 125 feet it cut the West or Grand Portage lode, which was found to be 62 feet wide with 14 feet of good copper ground on the footwall side and about 13 feet on the hanging wall side, with the middle of the vein poor. This lode has been found mineralized at other points by diamond drill work and was worked from the No. 1 shaft in the early days. During the year the company acquired the mineral rights of about 200 acres of land underlain by this lode. At No. 4 shaft developments and

stopes showed rock quite up to the average for 1911. At No. 5 shaft openings were up to the average and stopes were very good. Openings and stopes at No. 6 shaft were about the average. During the year, ground was broken for a new shaft No. 7, 2,000 feet south of No. 6. This had not been sunk through the overburden at the close of the year.

During the year 531,105 tons of "rock" were stamped, producing 11,461,410 pounds of "mineral," yielding 8,186,957 pounds of copper, or 15.4 pounds of refined copper per ton of "rock" stamped. The total cost per pound of refined copper was 11.89 cents.

Baltic, Champion, and Trimountain.—These three mines are located on the Baltic lode southwest of Houghton and are under the same management, that of the Copper Range Consolidated Co. The Baltic is an exceptionally strong lode, having a stoping width varying from 15 to 80 feet. The lode has produced considerable "mass" copper and also contains veinlets of copper minerals, including chalcocite, bornite, and copper arsenides. These minerals are recovered in the mill, and the arsenides probably account in part for the arsenical character of the Copper Range output.

During 1912 the Baltic operated three shafts with depths of 2,257 feet for No. 2; 2,526 feet for No. 3, and 2,457 feet for No. 4. A total of 10,547 feet of drifting and 679 feet of crosscutting was accomplished during 1911.

The new ground opened during the year showed distinct improvement as a whole. At No. 3 shaft openings were poor till near the close of the year when they showed distinct improvement. At No. 2 shaft the openings were exceptionally good. The openings in No. 4 shaft were not up to standard, though some rich stretches of new ground were located along the northern boundary of No. 4 territory.

A total of 652,433 tons of "rock" was stamped, producing 22,444,810 pounds of "mineral" yielding 13,373,961 pounds of refined copper, or 20.50 pounds of refined copper per ton of "rock" stamped. The cost per pound of refined copper was 10.94 cents.

The Trimountain is also opened by three shafts, with depths of 2,742 feet for No. 2; 2,267 feet for No. 3; and 2,191 feet for No. 4, at the close of 1912. A total of 7,746 feet of drifting, 401 feet of crosscutting and 1,770 feet of raising was accomplished. The openings made during the year were satisfactory. The openings all along the bottom of the mine show good ground.

The Champion, controlled jointly by the Copper Range Consolidated Co. and the St. Mary's Mineral Land Co., is opened by four shafts, with depths varying from 2,168 to 2,388 feet at the close of 1912. A total of 9,343 feet of drifting, 1,209 feet of crosscutting, and 1,740 feet of raising was accomplished. The openings made during the year were in average good ground at all the shafts.

A total of 765,306 tons of "rock" was stamped, yielding 28,460,500 pounds of "mineral," or 17,225,508 pounds of refined copper, a yield of 22.508 pounds per ton of "rock" stamped. The cost of refined copper per pound was 8.88 cents.

Regrinding plants were being installed at mills of the three companies for the treatment of the richer tailings.

Atlantic.—The Atlantic mine, also controlled by the Copper Range Consolidated Co., was not operated during the year, but the railroad and mill were utilized in handling Superior rock.

Superior.—The Superior is located northeast of the Baltic on the Baltic lode. The lode on this property is being opened by two shafts. At the close of 1912 No. 1 shaft had reached a depth of 2,014 feet and No. 2 a depth of 1,341 feet.

At No. 1 shaft development on the Superior lode was confined to the thirteenth and the fifteenth levels. Nothing was discovered on the thirteenth level, but on the fifteenth level a shoot of good ground was passed through for a distance of 300 feet, and at the close of the year copper rock had again been encountered.

On the lode discovered in 1911 in the hanging wall of the Superior lode and named the West lode, good copper ground was developed on levels 12 to 18.

At No. 2 shaft no commercial rock was developed.

During the year 172,322 tons of "rock" were stamped, producing 3,921,974 pounds of copper, or 22.76 pounds per ton of "rock" stamped. The cost of copper a pound was 12.75 cents.

La Salle.—Development was continued at the La Salle mine but no production was made during the year.

Hancock.—Development continued at the Hancock mine during 1912 at No. 1 shaft. No. 2 shaft was sunk to a depth of 4,001 feet, and stations were cut at the thirty-ninth, forty-fourth, forty-ninth, and fifty-third levels.

It is expected that rock shipment will be begun during 1913.

Houghton.—The Houghton ground lies between the Isle Royale and section 16 of the Atlantic.

During 1912, operations were conducted in what is believed to be the Superior lode, at the 620-foot level and in a winze 200 feet below that level, with encouraging results. A limited amount of development was conducted on the lower or East lode and some copper ground was encountered.

Wyandot.—At the Wyandot operations were continued in exploratory shaft No. 11, the crosscut to the east on the 700-foot level being advanced to a distance of 2,646 feet from the shaft, where it was discontinued in badly broken ground.

In this crosscut 13 amygdaloid lodes were encountered. Development work on the No. 8 lode during the year was encouraging.

Winona.—During 1912, 3,060 feet of development work was accomplished. There were stamped 181,148 tons of "rock" yielding 3,586,520 pounds of "mineral" and 2,307,237 pounds of refined copper, an average of 12.73 pounds of refined copper per ton of "rock" stamped.

Mayflower.—Diamond-drill exploration was continued at the Mayflower with encouraging results, but further exploration of this character is considered desirable before the sinking of a shaft is undertaken.

Old Colony.—Diamond drilling exploration was continued at the Old Colony during the year.

St. Louis.—At the St. Louis a shaft was sunk to a depth of about 500 feet.

Oneco.—During the year the shaft was sunk at the Oneco to a depth of 1,250 feet. Exploration was conducted on the eleventh and the twelfth levels. The explorations encountered fair character of vein material, but did not develop commercial rock.

New Baltic.—Development was confined to the 500-foot level and largely to the west of the shaft, where the west crosscut was extended

to a point 1,575 feet from the shaft. At a distance of about 1,500 feet from the shaft a vein fully 25 feet in width was encountered that contains rock of commercial grade. This will be explored by drifts.

New Arcadian.—A shaft was started in June, 1912, which had reached a depth of 500 feet on April 1, 1913.

Contact.—Diamond-drill operations were conducted on the Contact property during the year. Some copper-bearing lodes were encountered but none of very great promise.

Laurim.—Development was continued during the year. The drifting—3,533 feet—on levels 11 to 14 showed poorer ground than was opened in 1911.

KEWEENAW COUNTY.

In 1912 Keweenaw County produced 33,976,822 pounds of copper and 53,000 fine ounces of silver, being 15.5 per cent of the copper and 10.0 per cent of the silver produced in the Lake district. The county occupies the northern part of the Keweenaw Peninsula and contains the northern portion of the copper belt. This section of the belt produced considerable copper in the early days of Lake mining, but of late years has furnished a comparatively small percentage of the total output. Developments, however, indicate that the county should increase in importance in the future.

The following table shows the production of "rock" and "mineral" and the average yield in silver and copper in Keweenaw County in 1911 and 1912:

Production of "rock" and "mineral" and average yield in silver and copper in Keweenaw County in 1911 and 1912.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1911	37,053	32,079,885	18.8	0.94	45,225,456	70.9	1,704,048
1912	53,000	33,976,822	19.2	.96	48,633,935	69.8	1,772,817

From this table it is seen that in 1912 there was an increase in the quantity of "rock" treated, and also an increase in the quantity of copper recovered per ton of "rock."

Allouez.—The Allouez mine is north of the North Kearsarge and, as in recent years, operations have been confined to the Kearsarge lode. As this lode does not outcrop on Allouez property, the shafts were started in the hanging wall at a steep angle and flattened to the dip of the copper-bearing bed just before reaching it. This plan avoids the expense of long crosscuts necessitated by vertical shafts.

At the close of the year No. 1 shaft had a depth of 3,422 feet and No. 2 shaft a depth of 3,382 feet. A total of 8,517 feet of openings at the two shafts developed ground of average grade.

A total of 333,618 tons of "rock" was stamped during the year, yielding 8,787,120 pounds of "mineral," or 5,525,455 pounds of refined copper, an average of 16.56 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 13.52 cents.

Ahmeek.—The Ahmeek mine, lying north and east of the Allouez, is located on the Kearsarge lode. The lode is opened by four shafts. No. 1 has a depth of 2,472 feet. A total of 4,486 feet of openings was

accomplished at this shaft. The openings to the north show ground of average quality. To the south the same is true of the fifteenth, sixteenth, and seventeenth levels, but the sixth, tenth, and fourteenth were poor throughout the year.

No. 2 shaft had a depth of 2,643 feet at the close of 1912. A total of 3,808 feet of drifting disclosed ground of average grade. No. 3 shaft had a depth at the close of the year of 2,136 feet, and No. 4 shaft of 2,146 feet. A limited amount of drifting at these shafts developed ground of average value.

A total of 652,260 tons of "rock" was stamped, yielding 23,945,315 pounds of "mineral," and 16,455,769 pounds of refined copper, or 25.2 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 7.85 cents. Dividends amounting to $1,100,000 were declared during the year.

Mohawk.—The Mohawk mine, lying east of the Ahmeek, carries the outcrop of the Kearsarge lode for more than a mile and also contains several cross fissures carrying arsenides of copper, which have been mined to a considerable extent in the past. Operations were conducted through five shafts.

A total of 787,941 tons of "rock" was stamped, yielding 15,901,500 pounds of "mineral," or 11,995,598 pounds of copper.

Ojibway.—Development was continued at this property during the year.

Cliff.—A limited amount of exploration at the Cliff mine did not disclose commercial "rock."

Keweenaw.—During the year the company acquired 5,682 acres of additional land that includes the Ashbed lode. By an exchange of stock the property of the Phoenix Consolidated Copper Co. and the Washington Copper Mining Co. was acquired, giving the company control of about 13½ miles along the strike of the Ashbed lode. Late in the year the exploration of this lode by means of diamond drills was begun.

ONTONAGON COUNTY.

In 1912 Ontonagon County produced 4,685,291 pounds, or 2.1 per cent of the copper produced in the Lake district. Ontonagon County contains the southwestern portion of the copper belt. This portion has not been so thoroughly developed as the others, and consequently the geology is less understood than in the more northern counties. So far as developed the lodes are more bunchy than to the north and have produced a relatively high percentage of mass copper. The production of 1912 was derived wholly from amygdaloid rock.

The following table shows the production of the county in 1911 and 1912:

Production of "rock" and "mineral" and average yield in silver and copper in Ontonagon County in 1911 and 1912.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1911	513	3,187,817	15.7	0.78	4,477,965	71.2	202,569
1912	.....	4,685,291	9.4	.47	6,903,972	67.8	493,523

The production for 1912 shows a slight increase over that of 1911. The developments in the county for the last few years have been very encouraging, and it will probably show an increase in production in the future.

Adventure.—Operations during the year were confined to the No. 5 shaft. At a depth of 1,500 feet a crosscut was extended 1,151 feet, cutting three amygdaloid lodes that carried copper and were explored to some extent without very encouraging results.

At a depth of 1,190 feet a drift was started to explore a lode cut by the shaft. Copper rock was developed for a distance of 103 feet. In diamond drilling vertically from the bottom of the shaft, two amygdaloids were cut which showed fairly good quantities of copper.

Mass.—The Mass mine, adjoining the Adventure on the southwest, carries six known copper-bearing amygdaloid lodes, the Knowlton, the Mass, the North Butler, the Butler, the Ogima, and the Evergreen. In addition, the position of the property makes it probable that the newly discovered lodes in this part of the district may be present in the Mass ground. The main developments for the year were from "B" and "C" shafts on the Butler and Evergreen lodes, and the results were very satisfactory.

Scarcity of labor and an interruption in the transportation of "rock" to the mill, due to the repairing and rebuilding of railroad trestles, led to a smaller production than would otherwise have been made.

Michigan.—The Michigan mine has three shafts on the Calico lode, with crosscuts reaching to the Branch lode and to other lodes of less importance. In recent years the production has been largely from the Calico and the Branch lodes, though other lodes have contributed in the past. The mine has been a famous producer of "mass" copper, and the Branch lode, though narrow, is one of the richest lodes of the district.

The Calico lode is from 5 to 25 feet wide in the upper workings, but narrows to 4 or 6 feet at the 2,000-foot level. In the upper workings the copper occurs as a pay streak on the footwall, with patches of good ground on the hanging wall and in the center of the lode. But little exploration was carried on by the company during 1912.

The production for the year was made by tributers working in the upper levels of the old mine, who extracted 162,590 pounds of copper.

Victoria.—The Victoria is the most southwesterly of the Lake mines that have made important production. The first attempts at copper mining in the district are said to have been made at this locality, though its recent period of productiveness began in 1906. The present production is from the Forest lode. The old No. 2 shaft, through which present operations are carried on, was sunk 25 feet below the twenty-third level. Exploration at this shaft was, on the whole, encouraging. Explorations were carried on at No. 6 shaft, but not of sufficient extent to demonstrate the value of the ground adjacent to this shaft.

A total of 131,955 tons of "rock" was stamped, yielding 2,033,509 pounds of "mineral" and 1,224,911 pounds of refined copper.

Lake.—The new Lake shaft was completed during the year, and development underground was continued, as well as the equipment of the surface plant preparatory to regular shipment of "rock." Shipments were made during part of the year to the Baltic mill from the stock pile and from "rock" extracted during development.

North Lake.—During the year a shaft was started on this property to explore the lodes previously encountered in diamond-drill exploration.

Indiana.—The principal work for the year was the sinking of the main shaft, which at the close of the year had a depth of 1,204 feet. At a depth of 1,400 feet it is planned to cut a station and drift for the lode encountered in No. 2 drill hole. Several copper-bearing formations were encountered in sinking the shaft, but were only slightly explored.

Algomah.—Exploration was continued through the year both by drifting and with diamond drills. Sufficient data have not yet been obtained, however, to give a clear understanding of the structure in this section.

South Lake.—During the year a shaft was started to explore the lodes previously located by diamond drills. On January 30, 1913, the shaft had reached a depth of 215 feet. Between 110 and 210 feet it passed through three amygdaloid lodes carrying good copper values. These lodes were respectively 18, 10, and 40 feet in thickness.

MISSOURI.

By J. P. Dunlop.

PRODUCTION.

VALUE.

The value of the mine output of silver, copper, lead, and zinc in Missouri in 1912 was $34,914,761, compared with $30,171,311 in 1911. The value of the lead, silver, and copper showed a decrease, while the value of the zinc output increased $4,877,328. The production of zinc concentrates in Missouri in 1912 was the largest ever made, and the average price paid for all classes of zinc concentrates was far in excess of that received in 1911. The recoverable lead content of Missouri lead concentrates sold in 1912 was equal to 42 per cent of the smelter production of primary lead in the United States derived from domestic ores, and the recoverable spelter content from Missouri zinc concentrates sold in 1912 was 42 per cent of the primary spelter produced by smelters from domestic ores in 1912.

SILVER.

The following table shows the production of silver in Missouri in the years 1907 to 1912, inclusive:

Production of silver in Missouri, 1907–1912.

Year.	Silver.		Lead concentrates, silver-bearing.
	Quantity.	Value.	
	Fine ounces.		*Short tons.*
1907	25,692	$16,957	.....
1908	49,131	26,039	26,488
1909	14,188	7,378	31,000
1910	33,096	17,872	35,002
1911	49,867	26,430	51,109
1912	35,438	21,794	31,183

The quantities given in the first column of the foregoing table are those of recovered silver. The silver content of the ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied upon for the silver pro-

duction. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of concentrates smelted during that year. The reason for this is that the silver content is so small in quantity that the silver bullion is stored and refined in batches. If a series of years be taken into account, the concentrates are seen to average about 1 ounce of silver to the ton. The value is estimated at the average New York price according to the United States Mint.

COPPER.

The production of copper in Missouri in 1912 was 440,725 pounds, valued at $72,719, as compared with 640,411 pounds, valued at $80,051, in 1911. The mines of the North American Lead Co., which produced some copper as well as nickel and cobalt in the years 1908 and 1909, were idle during 1912. The copper output for 1910, 1911, and 1912 was derived from concentrates recovered in dressing lead ore mined in St. Francois County, in southeast Missouri.

LEAD AND ZINC.

The production of lead and zinc in Missouri in 1912 is shown in the following table:

Production of lead and zinc in Missouri in 1912, by districts, in short tons.

District.	Ore.							
	Lead concentrates.				Zinc concentrates.			
	Galena.		Carbonate.		Sphalerite.		Silicate and carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Southwest Missouri:								
Alba-Neck City	816	$45,562	.....	.....	17,966	$912,087	66	$1,246
Ash Grove-Everton	80	4,015	.....	.....	.....	.....	158	3,996
Aurora	49	2,271	19	$847	913	39,292	1,965	51,109
Carl Junction	120	6,712	.....	.....	7,457	392,952	.....	.....
Carthage	51	2,648	.....	.....	3,239	150,408	28	852
Cave Springs	384	21,454	.....	.....	5,979	316,724	.....	.....
Duenweg-Porto Rico	2,747	151,985	35	1,241	21,728	1,087,730	1,325	37,707
Granby	306	16,475	66	2,624	3,109	143,903	9,913	321,877
Joplin	4,689	252,085	19	653	43,032	2,151,198	2,520	71,592
Oronogo	1,719	91,649	.....	.....	11,015	510,904	.....	.....
Pioneer and McDowell	.....	.....	.....	.....	152	7,604	.....	.....
Sarcoxie-Reeds	.....	.....	.....	.....	342	19,328	255	7,490
Sherwood-Thoms Station	952	51,953	.....	.....	17,226	857,883	.....	.....
Spring City-Beef Branch	766	42,005	153	4,629	2,354	93,164	3,146	86,207
Springfield	227	13,421	.....	.....	1,777	106,900	.....	.....
Spurgeon	580	30,257	69	2,829	593	29,743	33	784
Stotts City	8	440	.....	.....	250	12,624	.....	.....
Webb City - Carterville - Prosperity	24,115	1,349,251	.....	.....	101,618	5,172,467	39	1,063
Wentworth	.....	.....	.....	.....	1,480	75,575	376	11,098
Zincite and Klondike	65	3,498	.....	.....	4,716	265,144	.....	.....
Wetherill	.....	.....	.....	.....	.....	.....	1,297	25,840
	37,674	2,085,681	361	12,823	244,946	12,345,630	21,121	620,861
Central and southeast Missouri	218,803	9,849,854	.....	.....	40	1,292	1,051	21,020
State total:								
1912	256,477	11,935,535	361	12,823	244,986	12,346,922	22,172	641,881
1911	258,006	12,460,902	234	8,358	217,812	8,680,559	20,119	477,420
1910	247,861	11,286,750	197	6,385	232,341	9,342,139	23,826	561,803
1909	249,151	10,893,024	385	11,124	229,023	9,445,826	28,525	677,213
1908	218,213	8,629,039	664	18,220	198,340	6,800,359	20,601	451,607
1907	193,528	10,535,890	357	11,764	222,347	9,208,465	18,733	427,146

Production of lead and zinc in 1912, by districts, in short tons—Continued.

District.	Metal content.[a]			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Southwest Missouri:				
Alba-Neck City	652	$58,680	9,902	$1,366,476
Ash Grove-Everton	61	5,490	51	7,038
Aurora	50	4,500	1,104	152,352
Carl Junction	97	8,730	3,981	549,378
Carthage	41	3,690	1,714	236,532
Cave Springs	300	27,000	3,191	440,358
Duenwig-Porto Rico	2,201	198,090	11,795	1,627,710
Granby	281	25,290	5,292	730,296
Joplin	3,727	335,430	23,369	3,224,922
Oronogo	1,355	121,950	5,792	799,296
Pioneer and McDowell	----------	----------	81	11,178
Sarcoxie-Reeds	----------	----------	268	36,984
Sherwood-Thoms Station	756	68,040	8,673	1,196,874
Spring City-Beef Branch	693	62,370	2,147	296,286
Springfield	184	16,560	1,012	139,656
Spurgeon	510	45,900	318	43,884
Stotts City	6	540	134	18,492
Webb City-Carterville-Prosperity	19,190	1,727,100	53,535	7,387,830
Wentworth	----------	----------	940	129,720
Zincite and Klondike	52	4,680	2,571	354,798
Wetherill	----------	----------	303	41,814
Total	30,156	2,714,040	136,173	18,791,874
Central and southeast Missouri	146,913	13,222,170	378	52,164
State total:				
1912	177,069	15,936,210	136,551	18,844,038
1911	178,868	16,098,120	122,515	13,966,710
1910	161,016	14,169,408	129,589	13,995,612
1909	159,435	13,711,410	130,162	14,057,496
1908	144,459	12,134,556	107,404	10,095,976
1907	138,675	14,699,550	116,752	13,776,736

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

The total value of the recoverable metallic content of the lead and zinc concentrates produced in Missouri in 1912 was $34,780,248, an increase of $4,716,438 over that for 1911. The production of lead concentrates in Missouri in 1912 (of which all but 361 tons were galena) was 256,838 short tons, valued at $11,948,358, as compared with an output of 258,240 tons, valued at $12,469,260, in 1911, a decrease of 1,402 tons in quantity and of $520,902 in value. Of this 1912 production of lead concentrates 218,803 tons, valued at $9,849,854, was derived from southeast and central Missouri, a decrease of 342 tons in quantity and of $443,546 in value. The average metal content of the lead concentrates from these districts was 67.1 as compared with 67.3 in 1911, and the value per ton in 1912 was $45.01, a decrease of $1.93. The quantity of recoverable lead in southeast and central Missouri concentrates in 1912 amounted to 146,913 tons, a decrease of 841 tons. The output was equal to over 35 per cent of the primary lead smelted or refined from domestic ores in the United States in 1912.

Shipments of lead concentrates from southwest Missouri were 38,035 tons, valued at $2,098,504, as compared with 39,095 tons, valued at $2,175,860, in 1911. The lead carbonate concentrates

amounted to only 361 tons, valued at $12,823, an increase of 127 tons. The average metal content of the galena concentrates from southwest Missouri was 79.5 per cent, and the average price per ton was $55.36, or 39 cents less per ton than in 1911. The quantity of zinc blende concentrates sold from Missouri mines in 1912 was 244,986 tons, valued at $12,346,922, an increase of 27,174 tons in quantity and of $3,666,363 in value when compared with the 1911 figures. All of the blende concentrates except 40 tons was produced in southwest Missouri. The average price received per ton was $50.44 and the average recoverable zinc content was 58.4 per cent. The average price paid per ton in 1911 was $39.86 and the average recoverable zinc content was 58.7 per cent. The marketing of some concentrates having a high iron content was the principal cause of the reduction in recoverable zinc content in sphalerite concentrates recovered from "soft ground." The recoverable zinc content of the sphalerite concentrates derived from "sheet-ground" mines was the same in the years 1911 and 1912. The average price received for sphalerite concentrates was the highest ever recorded in the United States, being $10.23 in excess of the average price for 1911.

The zinc carbonate and silicate concentrates sold in 1912 amounted to 22,172 tons, valued at $641,881. This was 2,053 tons more in quantity and $264,461 greater in value than the sales in 1911. The output in 1912 was almost mainly from southwest Missouri, the shipments from southeast Missouri being only 1,051 tons, valued at $21,020, as compared with 510 tons, valued at $11,576, in 1911. The average recoverable metal content of the zinc carbonate and silicate concentrates was 40.4 per cent in 1911 and 38.8 per cent in 1912. The average value per ton in 1912 was $28.95 as compared with $23.73 in 1911.

The combined value of lead and zinc concentrates from the southeast and central Missouri in 1912 (which produced about 85 per cent of the lead) was $9,872,166, or $436,800 less than in 1911. The total value of the southwest Missouri lead and zinc concentrates was $15,064,995 as compared with $11,318,273 in 1911, an increase of $3,746,722.

The total quantity of crude ore or "dirt" mined and treated in 1912 amounted to 13,385,511 short tons, an increase of 1,248,723 tons, or approximately 10 per cent more than the quantity mined and treated in 1911. As the total amount received for all classes of lead and zinc concentrates sold in 1912 was $24,937,161, the average value per ton of crude ore or "dirt" mined and treated was $1.86.

In the following tables showing the tenor of crude ore ("dirt") and concentrates from Missouri it has been considered advisable to segregate the ores of different nature. For instance, the disseminated lead ore from southeast Missouri differs radically from the lead and zinc ores from the so-called "soft-ground" deposits of southwest Missouri, and these in turn differ from the "sheet-ground" deposits of the same region. Each class of ore has its peculiar problems of mining and ore dressing. This fact makes desirable the separate treatment of the statistical data. Generally speaking, the tables reflect very closely the conditions of the industry.

Tenor of crude lead and zinc ore and concentrates produced in southwest Missouri in 1911 and 1912.[a]

		1911	1912
	"Soft ground." [a]		
Total crude ore	short tons	3,217,166	3,856,045
Total concentrates in crude ore	per cent	4.5	4.21
Lead	do	.4	.34
Zinc	do	4.1	3.87
Metal content of crude ore	do	2.6	2.41
Lead	do	.3	.27
Zinc	do	2.3	2.14
Average lead content of galena concentrates	do	79.9	79.5
Average lead content of lead carbonate concentrates	do	54.7	54.8
Average zinc content of sphalerite concentrates	do	58.9	58.3
Average zinc content of silicates and carbonates	do	40.4	38.8
Average value per ton:			
Galena concentrates		$54.41	$54.43
Lead carbonate concentrates		$35.72	$35.52
Sphalerite concentrates		$40.80	$49.99
Zinc silicates and carbonates		$23.76	$28.95
	"Sheet ground."		
Total crude ore	short tons	4,944,910	5,465,100
Total concentrates in crude ore	per cent	2.6	2.62
Lead	do	.5	.46
Zinc	do	2.1	2.16
Metal content of crude ore	do	1.64	1.62
Lead	do	.4	.36
Zinc	do	1.24	1.26
Average lead content of galena concentrates	do	79.9	79.6
Average zinc content of sphalerite concentrates	do	58.6	58.6
Average value per ton:			
Galena concentrates		$56.50	$55.83
Sphalerite concentrates		$39.79	$50.84

[a] Including also the small production of lead and zinc ores in central Missouri.

Tenor of crude lead ore and concentrates in southeast Missouri disseminated lead ore in 1911 and 1912.

		1911	1912
Total crude lead ore	short tons	3,974,712	4,064,366
Galena concentrates in crude ore	per cent	5.5	5.3
Lead content in crude ore	do	3.7	3.35
Average lead content of galena concentrates	do	67.3	67.1
Average value per ton of galena concentrates		$46.94	$45.01

SOUTHWEST MISSOURI.

AREA, ORES, DEPOSITS.

The southwest Missouri lead and zinc area includes the largest part of the Joplin region, the remaining portion lying in southeast Kansas and in northeast Oklahoma. The ore occurs in the Boone limestone and in rocks of Kinderhook age, both belonging to the lower Carboniferous. The ore deposits are found in Jasper, Newton, Lawrence, Greene, and adjoining counties. This area produces about four-fifths of the lead and zinc ore raised in the Joplin region.

The lead ores are galena, with a small quantity of lead carbonate, locally known as "dry bone." The zinc ores are sphalerite, or zinc blende, or "jack," zinc carbonate (smithsonite), and zinc silicate (calamine), both of the latter locally called "silicate." The galena contains but a small fraction of an ounce of silver to the ton of lead

concentrates, and although ordinarily it is not desilverized, yet occasionally the refineries find it advantageous to add lead from the Joplin region to their charges without, however, making any record of the silver content. In this way an unknown but small quantity of silver is recovered from southwest Missouri lead ore. The zinc ores, sphalerite, smithsonite, and calamine contain notable quantities of cadmium, being fully as rich in this respect as the zinc ores of Silesia, which are the source of the cadmium production of Europe. The discussion of the cadmium content of these ores is taken up more fully in the chapter in Mineral Resources for 1908, entitled "Cadmium."

The ore deposits of the Joplin district vary in character with the depth of mining. The shallower ores beginning at the surface are universally pockety and are found in residual clays or in "runs" in the basal breccias of the region. The breccias and the forms of the "runs" are largely, if not altogether, due to solution of the limestone strata. One form of run, which is fairly numerous, is the "circle" deposit, which, in the popular view, has come to be nearly synonymous with rich deposits. Small veins, vertical sheets, and thin crevice deposits are often met with in prospecting, but unless they develop into stringers leading into paying ore bodies are forgotten in the multitude of rich pockety deposits which the district has yielded. The blanket deposits or "sheet ground" are found in the Grand Falls chert member of the Boone limestone at depths varying from 125 to 275 feet, depending on the topography and the geologic structure. Below this horizon there are, in the rocks of Kinderhook age, deposits of disseminated ore. They have been struck in prospect shafts or drill holes near Springfield, Aurora, Granby, Carterville, Joplin, Hornet, and Cave Springs, in Missouri; at Galena, in Kansas; and at Quapaw, in Oklahoma.

ORE PRODUCTION.

Mining and milling practice in the Joplin region is so well known through the numerous articles that have appeared in the mining press of the country that but few words are necessary here. The type of mill erected in the district is carefully chosen to fit the needs of the particular kind of ore body to be exploited, and, being based on the evolutionary experience of nearly 40 years, is, in general, wisely selected.

In early days of zinc mining in the district when only the richest runs and pockets of the "disseminated" deposits could be profitably worked and the life of the individual mine was necessarily short, a very simple type of concentrating plant came into use. It was equipped with a rougher jig and a cleaner jig and had a capacity of 80 to 100 tons of crude ore per 10-hour shift. When a deposit was worked out, the mill could be easily and cheaply moved to another deposit. When the increased price of concentrates made it possible to mine lower-grade ore, and the life of the deposits was thereby lengthened, somewhat larger and more complete milling plants came into vogue. Sand jigs and concentrating tables were added to the equipment, and the capacity was raised to 200 or more tons per shift. Such mills, developed by the necessities of local conditions, came to

be characterized throughout the lead and zinc regions of the Central States as the "Joplin type."

A further increase in the price of concentrates and the development of large bodies of low-grade "sheet-ground" deposits, insuring permanence and stability of operation and necessitating every refinement of concentration, have resulted in the modern "sheet-ground mill" with capacity from 350 to 1,000 tons of crude ore per 10-hour shift, driven by steam, natural gas, or electricity, with complete equipment of ore-saving devices and with attendant economies of power, operation, and concentration.

ORE SELLING.

As was noted in the introduction to this chapter, the lead and zinc ores of the Central States when marketed locally are sold on a plan which differs somewhat from the methods in vogue in the Western and other States where more complicated ores prevail. The producer is paid by the ton of concentrates, all ores being sold in that form. The price is arranged on a sliding scale, the foundation of which is the price paid for ores of a certain standard, namely, the "basis." In each of the ores a "basis" is arbitrarily taken which represents as nearly as may be the average metallic content of clean concentrate. In sphalerite or zinc blende concentrate the basis is 60 per cent (theoretical composition, 67 per cent) of metallic zinc, by wet assay or analysis; in the oxidized zinc ores, the carbonate and the silicate, the basis is 40 per cent (theoretical, 52 and 54 per cent) metallic zinc; and in galena concentrates the basis is 80 per cent (theoretical, 87 per cent) metallic lead. The buyer will offer so much for 60 per cent zinc ore which becomes the "base price." If the assay shows the concentrates to vary from the basis, $1 is added to the base price for each per cent of zinc above 60 and $1 subtracted for each per cent less than 60. Deduction is made for moisture, all concentrates being sold on dry, or net, weight. Penalties are exacted for the presence of undesirable elements, as iron, bitumen, barite, fluorspar, etc. One dollar is deducted for each per cent of iron above 1 per cent. The first ore sold from the new Miami district was penalized 2 "per cent"; that is, $2 was arbitrarily deducted for the bitumen clinging to the concentrates, but this deduction is no longer made, and Miami sphalerite concentrates in 1912 brought about the average price paid for concentrates of like zinc and iron content derived from other camps in the Joplin field.

Fluorspar occurs in the zinc concentrates of western Kentucky and southern Illinois, but neither fluorite nor barite are found in quantity in the ores of the Central States except in some mines in central Missouri and in a single mine in the Joplin district. The practice of buying zinc blende concentrates on an assay basis became general in 1899, though it began in a small way a few years earlier. Formerly the ore was bought on "flat bid"—that is to say, the buyer made a visual inspection and mental estimate of the metallic contents and then offered so much per ton for the particular concentrates in question. An expert buyer can estimate the metallic contents very closely. Galena concentrates are generally bought on flat bid, though buying on assay is increasing. Ore which is sold in lump,

such as hand-picked galena, lead carbonate, and carbonate and silicate of zinc, is very generally sold on flat bid.

ASSAYS.

Several of the assayers in the Joplin district make a practice of saving the remnants of blende samples analyzed during the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which sample an average or composite assay for the year is made. Each assay thus represents several thousand lots. Two representative series of such composite assays are given below. In most cases each sample included in the composite assay represents a carload lot of concentrates.

The first series, by W. W. Petraeus, of Joplin, gives the result of analyses of composite samples from the general district for the last 14 years. The analyses for 1897–1905, inclusive, were published in the Lead and Zinc News, volume 9, January 15, 1906, page 8. The analyses for 1906–1912, were kindly communicated by Mr. Petraeus. Iron was not taken into account until 1900. Some 400 scattering assays, made in 1895–96, are excluded from the table.

Composite assays of zinc blende from the Joplin region, 1897–1912.

[W. W. Petraeus, analyst.]

Year.	Number of lots in the composite.	Percentage of zinc.	Percentage of iron.	Percentage of lead.	Percentage of copper.	Percentage of cadmium.
1897	600	56.64				
1898	1,299	56.99				
1899	3,715	56.67				
1900	3,500	57.36	0.22			
1901	3,683	57.53	2.02			
1902	5,776	57.08	2.24			
1903	6,014	57.30	2.00			
1904	6,220	57.24	2.10			
1905	4,628	57.97	1.84	1.00	0.001	0.198
1906	5,644	57.2	2.00			
1907	6,813	56.8	1.93			
1908	7,837	56.4	1.76			
1909	9,002	56.3	2.00			
1910	8,892	56.6	2.10	1.02	.06	.399
1911	8,920	57.1	2.40			
1912	9,474	57.7	2.40			

The next series of composite assays was communicated by Prof. W. George Waring, of Webb City. The original samples were of ores from the different camps of the district except where otherwise indicated. The methods used in making these assays have been published.[1]

[1] Waring, W. G., The Volumetric determination of zinc: Jour. Am. Chem. Soc., vol. 26, No. 1, January, 1904. In addition to the composite assays for 1902 and 1903, shown in the table, the article gives the lead, copper, and cadmium content of a number of ores from individual mines in Missouri, Kentucky, and Illinois.

Composite assays of zinc blende from the Joplin region, 1900–1911.

[W. George Waring, analyst.]

Year.	Number of lots in the composite.	Zinc.	Iron.	Lead.	Cadmium.	Copper.
	Lots.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1900	3,894	57.30	3.03			
1901	5,172	56.00	3.30			
1901	2,757	55.30	3.86			
1901	[a] ±2,000	55.90	3.47			
1902	2,270	57.08	2.65	0.904	0.337	0.050
1903	2,145	57.75	2.32	1.072	.388	.049
1904	[a] 3,800	58.26	2.23	.701	.304	.049
1904	[b] 2,691	58.46	1.97	.720	.430	.050
1904	1,984	58.95	2.10			
1905	4,520	58.95	2.00			
1906	4,638	58.40	2.20			
1906	3,968	58.20	2.29			
1907-8	±4,000	58.70	2.00			
1909		[c] 57.40	2.60			
1910	6,377	[c] 57.90	2.60	.856	.450	.034
1911	5,653	58.20	2.35			
1912	6,709	56.72	2.50	1.070	.256	.022

[a] Joplin. [b] Webb City. [c] The composite sample included some lots of silicate ores.

The complete analysis of the composite sample of the 3,800 lots of concentrate from the Joplin district in 1904, sampled by C. V. Millar and analyzed by Waring, is as follows:

Analysis of composite sample of zinc blende from the Joplin region.

Zinc	58.26	Calcium carbonate	1.88
Cadmium	.304	Magnesium carbonate	.85
Lead	.70	Barium sulphate	.82
Iron	2.23	Silica	3.95
Manganese	.01		99.773
Copper	.049		
Sulphur	30.72		

PRICES AND PRODUCTION.

Not only was the sphalerite output of Missouri in 1912 the largest ever made, but the average base prices for all kinds of zinc concentrates were the highest ever recorded in the United States. For some choice grades of sphalerite $67 a ton was paid in September. The average quoted base prices for 60 per cent blende concentrates, were lowest in January and February, the lowest average base price quoted being $42 a ton. Prices stiffened to $50 and $52 in March and April. The former record price in 1905, $60 a ton, was exceeded in May. The average base price ranged from $53 to $59 in June, July, and August. In September all base-price records were exceeded when as high as $64.50 was paid for 60 per cent blende concentrates, and some high-grade ore was sold for $67 a ton. After the first week in October the average base price ranged from $52.75 to $56 per ton. Base prices for calamine, or zinc carbonate and silicate concentrates, were lowest in January and highest in October, ranging from $22 to $33 a ton. Base prices for galena concentrates varied from $48 in February to $67 in October. The average price paid for sphalerite or blende for 1912 was $50.44, as compared with $39.86 in 1911, and for zinc silicate or carbonate (calamine) concentrates it was $29.39

in 1912, $23.76 in 1911, and $23.58 in 1910. The average price paid for galena concentrates was $55.36, compared with $55.75 in 1911. These prices are not average base price quotations, but are the actual average prices calculated from the tonnage sold and the values reported to the United States Geological Survey by the sellers.

The prices received by the producers show that galena concentrates brought practically the same amount per ton in 1912 as in 1911, the decline of 0.3 per cent in the average lead content of the concentrates being taken into consideration. The average actual price of the sphalerite sold increased $10.58 a ton, although the concentrates from "soft ground" mines contained 0.6 per cent less zinc content and the concentrates from the "sheet ground" mines the same zinc content as in 1911.

It will be noted that the average per cent of lead concentrates recovered from crude ore from both "soft ground" and "sheet ground" mining declined. The recovery of zinc concentrates was approximately the same from the ore derived from the "sheet ground" mines for the years 1910, 1911, and 1912, indicating clearly that about 2.6 per cent of concentrates is what may be accepted as the approximate recovery for a term of years from this class of mines. The recovery of zinc concentrates from the "soft ground" mines declined about 0.3 per cent, a natural result of the working of thinner ground made profitable by the high prices.

The total tonnage of ore or "dirt" treated increased from 8,162,076 tons in 1911 to 9,321,145 tons in 1912. The ore treated from "sheet ground" increased over 638,000 tons and that from "soft ground" mines over 520,000 tons.

In 1912 the sphalerite concentrates derived from the "sheet ground" mines amounted to 117,955 tons and the galena concentrates to 25,056 tons. In 1912 the "soft ground" mines yielded 126,991 tons of sphalerite, 12,616 tons of galena, and all of the lead carbonate, zinc silicate, and zinc carbonate concentrates. The total value of all concentrates derived from "sheet ground" mines was $7,395,998, and from "soft ground" mines $7,668,977. This shows that the value of the production of concentrates from "soft ground" mining amounted to about $270,000 more than the production from "sheet ground" mining, although the ore or "dirt" milled or otherwise treated was 1,600,000 tons less.

High prices for concentrates naturally stimulated development in most of the camps in the Joplin region. Some of the new mines made large outputs. Properties long idle were again worked. Mines and milling plants were operated double shift in order to take advantage of the conditions prevailing. Land owners, lessees, and operators shared in the general prosperity. The miners and millmen who are usually employed on a sliding scale of wages, determined by the selling price of concentrates, automatically received higher wages, and in addition often were paid a bonus. The per cent of increased production over that of 1912 was larger in the Thoms Station district than in any other camp.

The Webb City-Carterville-Prosperity district, which includes many of the "sheet ground" mines, was again the largest producer of both blende and galena concentrates. It produced 64 per cent of the galena concentrates and over 41 per cent of the sphalerite sold in

southwest Missouri in 1912. In 1911 it produced over 63 per cent of the lead and 42 per cent of the sphalerite. The quantity of crude ore or "dirt" raised is a better indication of the extent of mining activity than the production of concentrates, for the "sheet ground" ore is of lower average tenor than the "soft ground" ore. The leading position of the district is more adequately shown by the fact that the estimated tonnage of ore mined in the Webb City-Prosperity district in 1912 was about 4,451,000 tons, very nearly half of the total tonnage of crude ore raised in southwest Missouri. Joplin, the second most productive district in 1912, showed a decrease in galena concentrates of about 1,400 tons but a considerable increase of zinc blende and zinc carbonate and silicate.

The production of all classes of concentrates at Duenweg gave that district third place among southwest Missouri districts by a considerable margin. The output of blende concentrates at the Alba-Neck City camp increased about 2,000 tons and the camp retained fourth place. The largest gain in zinc blende tonnage was made by the Thoms Station-Sherwood district, which advanced from thirteenth place in 1910 to fifth in 1912. The most important developments during 1912 are described under the various district reviews.

REVIEW BY DISTRICTS.

Alba-Neck City district.—The shipments of sphalerite concentrates from this district in 1912 increased about 2,000 tons, and several new mines were developed which will add to the 1913 yield. The sales of lead concentrates (816 tons) showed a large increase, though some of the largest shoppers of zinc blende concentrates reported no lead shipments whatever. The zinc blende production of the Quick Seven Mining Co. was again the largest in the district. Six shafts ranging from 150 to 164 feet in depth were in operation, and ore was also taken from an open cut caused by caving ground. The ore body comes to within 15 or 20 feet of the surface and the ground is very soft, so that the cost of breaking and hoisting the "dirt" is less than in most mines in southwest Missouri. There are on this land 4 concentrating plants having an aggregate milling capacity of 750 tons. The principal producing subleases were the Little Francis, 1909, Progressive, and Hub (old Texmo). The sphalerite from this property averages 61 per cent zinc and the "dirt" contains no galena.

The Little Mary Mining Co. was the next largest producer of sphalerite in the district in 1912. The concentrates sold averaged 62 per cent zinc and contained little or no lead. The concentrating plant has a capacity of 250 tons.

The Cliffwood Mining Co., on the Durston Mining Co.'s land, produced a large quantity of high-grade concentrates, but sold no galena. Two shafts were utilized to hoist ore from the 185-foot level. The 2 concentrating plants with capacities of 125 tons and 200 tons are operated by electric power. A large portion of the galena concentrates produced in the district as well as a good production of the blende concentrates came from the Reliance Mining Co.'s land. Among the lessees working were the Annalinda Mining Co., Greene & Co., Jessie Mining Co., Smart & Co., Lang & Stark, and F. L. Cole & Co.

The Virginia Mining Co. on the Weaver land produced more than 50 per cent of the galena concentrates shipped from the district. The "dirt" yields approximately 2 tons of sphalerite concentrates to 1 of galena. The shaft at this mine is 170 feet deep, and the concentrating plant has a capacity of 250 tons. The Aylor land was operated by the Eclipse Mining Co. (which made an output of zinc concentrates by means of hand jigs) and by the East Side Mining Co. The latter company has a 200-ton concentrating plant and made a good output of sphalerite.

The Stag Mining Co. operated the Big Kate mine and erected a 100-ton concentrating plant. The shaft at this mine is 185 feet deep and the output was of high-grade sphalerite. Other producers in 1912 were the Alba Tailing Co. on the Sponable land, Creola May Mining Co. on the W. E. Patton Land, Bulldog Mining Co. on the Calumet Zinc Co.'s land, Shamrock Mining Co. on the Bowen lease of the Federated Mining & Milling Co., Cathers Mining Co. on the Fox land, Horseshoe Mining Co. on the Haworth land, Howell & Sadler on the Wheeler land, W. R. Lively & Co. on the Robinson & Baker land, Busy Bee Mining Co. on Calumet Zinc Co.'s land, Salvator Tailing Co. on the Rochester land, and the Queen Elizabeth mine at Purcell.

Ash Grove-Everton district.—The mining in this vicinity is all shallow, none of the workings exceeding 50 feet in depth. The ore is raised by means of horse whims and cleaned on hand jigs. Most of the lead was mined on the Duncan land in Boone Township. The zinc carbonate and silicate produced was mainly the output of the lessees on the John A. Hall land near Corry. Burns & Co. erected a new crusher, jigs, and slime table in the latter part of the year.

Aurora district.—The production of this district in 1912 showed a decrease when compared with that of 1911 of 40 tons of lead concentrates and of 2,360 tons of sphalerite concentrates. The output of zinc silicate and carbonate increased 136 tons. A large proportion of the output was made by lessees working shallow ground, the crude ore or "dirt" being treated at custom mills or sold in the rough. Most of the mining was on a small scale, and little new work was undertaken other than that by the Chat River Mining Co. This company installed pumps on the United Zinc Co.'s land to lower the water level and enable the sublessees to mine ore which has been inaccessible since many pumping plants at mines working at lower levels have been idle. The 100-ton concentrating plant of the Sphalerite Mining Co. produced about 50 per cent of all the blende sold in 1912. The Buckeye mill, owned by C. C. Plank, was the largest producer of zinc carbonate and silicate and also made a fair output of sphalerite. The output was entirely from rough "dirt" purchased.

Lessees on the Stratton Bros.'s lease of the United Zinc Co.'s land produced about 20 per cent of the zinc silicate and carbonate of the district. The Early Dawn Mining Co. mined the old Sedalia and a lease on the P. W. Stewart land, recovering a good output of zinc silicate, which was treated in an 80-ton concentrating plant. This company installed a new Emerson pump, an underground tramway of 1,000 feet, and made preparations for a much increased output. Other producers of concentrates in 1912 were the lessees of the Black Land & Mining Co., Cleveland Aurora Mineral Land Co., Decatur Lead & Zinc Co., Geo. R. Tooker (Jones land), Kentucky Mining Co.,

and Midland Mining Co. Plank & Horine and the Jack Rabbit Milling Co. bought and milled rough "dirt" and tailings.

Carl Junction district.—The production of lead concentrates in this district almost doubled and the yield of zinc concentrates was 2,847 tons more in 1912 than it was in 1911. Several new mills were built and many drilling outfits were engaged in locating and proving up ore bodies. The Moler-Smith Lead & Zinc Co.'s production was less in 1912 than in 1911, and a smaller percentage of their concentrates was derived from open-cut mining. Lessees on the land sunk several new shafts and made a good production of high-grade sphalerite.

The United Zinc Co.'s lease on the Avondale land produced more sphalerite than any other property. In addition to the company's production the following subleases were productive: Carlson & Co., Webb City Lehigh, Teddy Bear, and C. L. Turner. Six shafts were operated in 1912. The United Lehigh mine is electrically operated, and the mill has a capacity of 250 tons.

On the Dynes lease of the W. H. Smith land the Gager Mining & Milling Co. and other lessees operated spasmodically. Considerable drilling was done on this property and also on the Ishpeming Mining Co.'s land. The only large producer on the United Zinc Co.'s lease of part of the Knight land was the Chicago Lehigh Mining Co. A new mill of 200 tons capacity, with complete electrical equipment, was started late in the fall of the year. Two shafts, one at the mill and the other connected to the mill by an 800-foot tramway, were used to hoist the ore.

The Century Mining Co. erected a new 100-ton mill on the Knight land and produced some concentrates. The Baby Kitty mine on this lease was also a producer, and the Federated Mining & Milling Co. was erecting a 300-ton plant.

The Weaver Mining Co., on the Anderson land, 4 miles north of Carl Junction, operated the 125-ton mill erected in 1911 and late in the year sold their property to the Rockford Mining Co. Weeks & Briggle also developed a lease on the Weaver land and erected a new mill.

Carthage district.—Prospecting continued active in this district in 1912, and the production of zinc concentrates increased 575 tons over the 1911 output. The largest production was made by the S. V. & D. Mining Co. The mill on the property has a capacity of 300 tons, and 2 shafts of 216 feet in depth were in use.

The Live Wire Mining Co. (Cornell), on the Sampson land, completed a new mill in January, 1912, and made a good output of high-grade sphalerite concentrates. The Wise Guy Mining Co.'s mill ran entirely on tailings from the old Vesuvius mine. The milling plant at the Vesuvius was moved to the Wakefield-Hodson land, where 400 feet of drifts were cut at the 225-foot level of the shaft and some ore was hoisted.

The Mariposa Mining Co. produced sphalerite, zinc silicate, and galena concentrates from the Amsden land and later subleased to the Hermosa Mining Co. The Old Persimmon mine, on the Buehler land, was worked by the Linzee Hill Mining Co. Ore was hoisted from the 210-foot level and milled in a 150-ton plant. The only production on the Mignonette land was made by J. L. Edwards from old tailings. Seven drill holes were sunk on this lease which were said to have dis-

closed good faces of ore at 110 to 150 feet and at 170 to 182 feet. Four new shafts and about 30 drill holes were sunk on the Glenn land, but no ore was treated in 1912.

Cave Springs district.—The production of galena concentrates increased from 317 tons in 1911 to 384 tons in 1912, and the production of blende concentrates increased from 4,497 tons in 1911 to 5,979 tons in 1912. The principal producer in the district was the H. L. Kramer mine, on the Miami Realty & Mining Co.'s land. Two shafts were operated. The 270-foot shaft, 6 by 14 feet in size, is equipped with a double-cage system, and the concentrating plant has a capacity of 500 tons, and is equipped with rougher, cleaner, and sand jigs and four tables.

The other large producers were the Big Brownie and Cave Springs leases on the Schmidt Bros. & Schemmerhorn land. Both leases are equipped with concentrating plants. Sublessees on the McCullough & Murdock lease of the Hartley land produced some high-grade sphalerite from a 100-foot shaft.

Duenweg-Porto Rico district.—The production of lead concentrates from this district in 1912 increased 385 tons and that of sphalerite 5,178 tons. There was a decline of 1,227 tons in the output of zinc carbonate and silicate. The largest producer of sphalerite was the Coahuila mine and the second largest the Vogey mine. The Central States mine yielded about 70 per cent of the zinc silicate concentrates, as compared with 80 per cent in 1911.

The December tract of the American Lead, Zinc & Smelting Co. (on which the Vogey mill, having a capacity of 1,000 tons per day (double shift), is situated) was operated by the owners and by Patton & Co. The July tract of the same company, which is equipped with a 200-ton mill, was idle. Sheet ground was mined at the Vogey, the ore coming from the 180-foot level.

The Coahuila Mining Co., on the Horton land, worked a 40-foot face of ore in sheet ground. The shaft is 240 feet deep, and the concentrating plant has a capacity of 300 tons. A sludge mill containing eight tables was added to the equipment in 1912.

The Carmean & Squires Zinc Mining Co. operated on the Trinity land. One shaft was used to hoist ore from the "sheet ground" at about the 200-foot level and the ore was milled at the Whitsett mill.

The old workings on the L. K. Smith land leased to Douglas & Anderson were subleased to various lessees, who hoisted quite a large tonnage of ore, which was treated at a 100-ton mill on the leasehold. The second largest production of lead concentrates and the third largest production of zinc concentrates in the district was reported by the Boston-Duenweg Mining Co. Most of the output was due to the operations of the Wilson Mines Co. There were several sublessees on the ground, but the only mill is the 250-ton concentrating plant of the Wilson Mines Co.

The Grand Haven Mining Co., on the Ping land, ran a 125-ton mill steadily during the year on ore from "soft ground." Two 150-ton concentrating plants were in operation by lessees on the Knol land. Ore from "soft ground" between 110 and 150 feet was hoisted through six shafts.

Operators of the Melrose and Nowata mines used a surface tramway, with locomotive and cars, to convey the ore from a distant shaft to a 200-ton concentrating plant. The output of galena and sphalerite

from ore in "sheet ground" formation was quite large. Most of the output of galena, zinc silicate, and sphalerite from the Royalty Land & Mining Co.'s property was obtained by R. L. McGee from a 110-foot shaft.

A new mill, electrically operated, and having a capacity of 150 tons, was erected by the Little Bob Mining Co., on the Walker land. The mill was operated the last eight months of the year and produced a large tonnage of both galena and sphalerite. Four shafts, ranging from 85 to 132 feet deep were used. The Duenweg Zinc Co., controlled by the same owners as the Little Bob Mining Co., sunk another shaft on the Walker land and are building a 150-ton plant.

The Central States mine on the Home Talent Mining Co.'s lease of the Hall land produced most of the zinc silicate ore in this district, although its output was much less in 1912 than in 1911.

A new operator in the "sheet ground" was the Thanksgiving Mining Co. Two shafts were sunk, and a completely equipped 300-ton concentrating plant was finished and operated in September.

The What Cheer Mining Co. sunk a new 220-foot shaft to the "sheet ground" on the C. A. Baker land and ran 200 feet of drifts, which opened up an 8-foot face of ore. The new mill of 250-tons capacity, which has a complete electrical equipment, was not operated in 1912.

The old Lincoln mine on the Jasper Royalty Co.'s land was reopened by the Gopher Mining Co. Active operations were commenced in July, 1912. The ore was mined at an average depth of 252 feet, and a large output of both lead and zinc concentrates was made at the electrically driven concentrating plant of 350 tons capacity.

Other producers in the district in 1912 were lessees on the Acme land and the Big Six Mining Co., Geo. Donnellan, Thomas Lacey, J. Thompson, lessees of the Crown Crest Lead & Zinc Co., Henry Weymann, H. H. Gregg, G. R. Blossom, and Sadtler Lead & Zinc Co.

Granby district.—The output of sphalerite concentrates in this district in 1912 was 1,221 tons and that of lead concentrates 294 tons less than in 1911. The production of zinc carbonate concentrates increased 508 tons.

Most of the producing territory belongs to the Granby Mining & Smelting Co., and the total production was large, the relative quantities of zinc silicate, zinc blende, galena, and lead carbonate being in the order named. Much of the mining by small companies and by individuals is in shallow workings that yield galena and zinc silicate ore. The larger producing lessees on the Granby lands were the Broken Hill Co., Cole Co., Golden Rule Mining Co., Jack Snipe Mining Co., Little Boss Mining Co., Mascot Mining Co., Katy Mining & Milling Co., J. R. Underwood Mining Co., Billiken Mining Co., Granby Sludge Co., Automobile Mining Co., Brotherhood Mining Co., Hash Richardson & Co., C. Wyatt & Co., Painter Dahnke & Co., W. W. Smith, and Howerton & Son. The depth of mining varied from very shallow openings to 250 feet, and 11 concentrating plants were operated in 1912.

The 200-ton concentrating plant of the Granby Mining & Smelting Co., the largest in the district, is so equipped that it can be used to concentrate either blende or calamine ore. Many of the lessees on this land have no concentrating equipment and a large tonnage of ore is treated at custom mills or sold in the rough.

The Mascot Mining Co. operated entirely on Granby land, and the only production on St. Paul Mining Co.'s land was by Dahnke & Co. An extensive drilling campaign was undertaken by the Granby Mining & Smelting Co. and others, and a large amount of territory was prospected.

Joplin district.—This district, as usual, made the second largest production in southwest Missouri. The 1912 sales of concentrates were as follows: Galena, 4,689 tons; lead carbonate, 19 tons; zinc blende, 43,032 tons; carbonate and silicate of zinc, 2,520 tons. The total value of all concentrates sold was $2,475,528. As compared with 1911 the sales of galena and lead carbonate decreased 1,795 tons, zinc blende increased 1,732 tons, and zinc carbonate and silicate increased 803 tons, and the total value increased $461,552.

The number of producers reporting was larger than in any other district, and the area included in the camp is more extensive. About 81 per cent of the zinc blende and 74 per cent of the galena concentrates were recovered from ore mined in "soft" ground.

Although the production of the Joplin district showed a substantial increase in output of zinc concentrates, the new mining developments were overshadowed by the activity and very largely increased output of the outlying camps at Thoms Station, Klondike, Carl Junction, and Spring City. Many of the mines in these camps are locally classed as belonging to the Joplin district and in considering the relative output compared with that of the eastern and extreme western districts of the Joplin region, these camps must be taken into consideration. Territory in the western part of the Joplin district, locally known as Central City and Gordon Hollow, was perhaps more thoroughly drilled and developed than other sections of the Joplin district, and new mills at the Priscilla, Geronimo, Hillside, and other mines were largely responsible for much of the new production in 1912.

The production of lead concentrates by lessees on the Joplin tract of the Granby Mining & Smelting Co. was much larger, and the production of zinc concentrates slightly larger than that from any other land, although individual mines in the district produced more than any single lease on the Granby property. The average depth of mining by Granby lessees was 160 feet, and 14 concentrating plants, with an average capacity of 150 tons each, were operated. The producing mines on the Granby lands were the Amalgamated, Bay State, Conqueror, Williams, Cripple River (formerly Katy Lou), Dunham, Jack Possum, Theurer, Omega, and Grace; also the Gravity, Connecticut, and Pearl tailing mills.

The next largest production of zinc blende came from the land of the St. Louis-Joplin Lead & Zinc Co. The ore was mined from levels between 100 and 200 feet, and five concentrating plants, ranging from 100 to 250 tons capacity, were operated in 1912. The land was prospected by drilling and new ore bodies were located in the "sheet ground" on the southwest quarter of the 400-acre tract. The principal producing leases on the St. Louis-Joplin land were the Joplin-Kentucky, Goodenough, A. B. C., John Jackson Mining Co.

The A. B. C. mine concentrating plant has a capacity of about 125 tons, but the "dirt" milled was so rich that the recovery of concentrates made in 1912 was probably larger than from any other "soft ground" mine in the district.

Lands owned by the Connor Realty Co. near the city of Joplin and at Central City produced a large quantity of sphalerite. The old Prairie Chicken mine, a large shipper for several years, was operated most of the year, being finally shut down because the ore body was exhausted. The Lola (formerly Long) made a good output. Over 50 per cent of the output of the Connor Realty Co.'s lands came from new mines at the Central City camp, although the Geronimo and Priscilla mines were not opened up until August. The shaft at the Geronimo is 140 feet deep, and the electrically-operated mill erected in 1912 has a capacity of 300 tons. The Priscilla mine of the Underwriters Land Co. has a shaft 100 feet deep and a 400-ton concentrating plant. The only other producer on the Connor land at Central City was the Short Creek Mining Co. There are 7 shafts ranging from 42 to 75 feet on this lease, which is also equipped with a small mill.

The Duquesne Mining Co., on the Mattes land, mined "sheet ground" at the 150-foot level. The 400-ton mill at this mine made a large quantity of blende concentrates, of which only a portion was sold in 1912.

There was much development in the western section of the Joplin district known as Gordon Hollow. Old mines were pumped out and operated, new ones developed, and several mills were erected. The principal shippers of concentrates from this portion of the district were the Independence Mining Co., R. W. Latshaw, Hillside Mining Co., Gordon Hollow Mining & Milling Co., Friel & Phillips, Gordon Hollow Land & Mining Co., the Tilho Mining Co., and the Betsy Mining Co.

The principal operators of "sheet ground" mines in the district, with the reported capacity of their concentrating plants, are as follows: Hecma Land & Mining Co., 150 tons; Sunnybrook Lead & Zinc Co. (formerly Hackett), 400 tons; Sampson Mining Co., 300 tons; Cragg & Co. (old Hero), on the Eyester lease of the Banner Investment Co., 150 tons; Muskingum Zinc & Lead Mining Co., 300 tons; Falls City Mining Co., 400 tons; Allington, Christy & Thornton (old Temagami), on Continental Zinc Co.'s land, 250 tons. The Martha Ball Mining Co. was building a 300-ton concentrating plant, to be operated with electric power, on the Liberty land adjoining the Falls City mine.

Other large producers of sphalerite were the New Dividend mine on the Midway tract of the American Zinc, Lead & Smelting Co., the Paragon and West Seventh Street mines on the Dirigo Land & Leasing Co.'s land, the Waneta and Little Mattie mines on the Clarence Lambert land, the Tom C. mine and other leases on the Rex land, Berry & Pickson on the Leckie land, lessees on the W. E. Johnson and the Home Land & Loan Co. properties, the Little Hoosier on the Leonard Realty Co.'s land, Homer Seals from various leases, lessees of P. L. Swartz land, of the United Zinc Co.'s land, and of the Taylor land (Old Dominion.)

The principal shippers of zinc silicate and carbonate in 1912 were the Snowstorm Mining Co. on the land of the Shoal Creek Mining Co., the No Name Mining Co. on the L. B. Jones land, Cawood & Walker and Cochran Bros. on the Saginaw Investment Co.'s land, and the Snowdrift Mining Co. on land of the Atchison Mining & Milling Co. The latter property also produced a good output of both galena and sphalerite concentrates. Lessees of the Shoal Creek Mining Co. were the largest producers of zinc silicate in the district.

The following properties made fair outputs of either lead or zinc concentrates: Rabbit Foot Zinc Mining Co., Inter-City Mining Co., Willard L. Butts, Anderson Mining Co., New Hope Mining Co., Alhambra Land & Mining Co. (Big Springs), Joplin Consolidated Mining Co., Empire Zinc Co., A. W. Grannis, Henry Weymann (Gray land), Missouri Lead & Zinc Co., A. Montgomery, Montgomery Lead & Zinc Co., Owensboro-Joplin Mining Co., Paoma Mining Co., Little Martha Mining & Milling Co., Pittsburg-Joplin Lead & Zinc Co., Roaring Springs Land & Mining Co., Rob Roy Zinc Co., J. B. Robb, and the South Joplin Lead & Zinc Co.

The custom concentrating plant of Lee Williamson was rebuilt and operated most of the year. The Hoo Hoo Mining Co. obtained a lease on the Expansion Realty Co.'s land, sunk shafts to both the "soft" and "sheet" ground formations, and erected a 150-ton concentrating plant. A new 250-ton plant was in course of erection by the Otis Mining Co. on the Realty Extraction Co.'s land.

Oronogo district.—In 1912 the production in the Oronogo district of lead concentrates increased 228 tons and of zinc blende concentrates 842 tons as compared with the output in 1911. Most of the producing territory in the district is owned by the Granby Mining & Smelting Co. Little of the "dirt" came from workings above the 70-foot level and nearly all of the production was made by three or four companies. The most prominent producer on Granby land was the old Oronogo Circle mine, which had a larger output of galena and blende concentrates than any other mine in Missouri with the possible exception of the Davey mines of the American Zinc, Lead & Smelting Co., at Webb City. Four shafts of 160, 240, 230, and 230 feet, respectively, were operated in 1912, and the ore was concentrated on the large 400-ton mill. Complete electrical equipment was installed to replace steam as power. Various improvements for the more rapid and economical handling of the ore were made. Steady development work has opened large bodies of ore sufficient to supply the mill for a long period, and 40 acres were added to the leasehold, making it 126 acres in all.

The Pinnacle Mining Co. had on the Granby land two 235-foot shafts in operation and produced a large output of both lead and blende concentrates. The "dirt" averaged 1 ton of galena to 4 tons of blende concentrates. The concentrating plant has a capacity of 250 tons. The only other large producer on Granby land in 1912 was the Oronogo Mining & Development Co., which erected a new concentrator in 1911. The old Needmore tract in the northern part of the Granby land, which formerly was a large producer from shallow workings, was idle.

Pioneer and McDowell districts.—The West Twenty Mining Co., at Fairview, southeast of Granby, was unfortunate in having the 200-ton concentrating plant erected early in 1912 destroyed by fire after a short run. The company had two shafts sunk to the "sheet ground." The only production from the McDowell district in Barry County was that of the Springfield Fissure Mining Co., which operated its plant during the months of July and August. The Owl Creek Mining Co. sunk a 197-foot shaft but produced no concentrates.

Sarcoxie-Reeds district.—The production of this district, which was entirely of zinc blende and zinc silicate, showed a large decrease when compared with the output of 1911.

The Cameron mine, which yielded nearly all of the blende concentrates shipped in 1912, was operated for a portion of the year by the American Zinc, Lead & Smelting Co. There is a 250-ton mill on the property, which is opened by a 242-foot shaft. The ore mined was chiefly between the 200-foot and the 225-foot levels. The Bear Cat Mining Co. obtained a lease of the mine late in 1912.

The Lone Pilgrim mine, on the H. B. Boyd land, produced blende and zinc silicate concentrates, and the mine yielded most of the zinc silicate mined in the camp.

H. A. Cale and sublessees of the Stealey Development Co. on the Webb land, 4 miles west of Sarcoxie, shipped zinc silicate concentrates. The Clark & Willoughby land, 5 miles west of Sarcoxie, was purchased by the Mercantile Metal Milling Co., and the E. H. Newby lease, formerly worked by the Lucky Ben Mining Co., was transferred to the Reo Mining Co. One 145-foot shaft was sunk to the ore body and another shaft was started. The leasing company also was building a 125-ton concentrating plant. The district will show a much increased output in 1913.

Thoms Station-Sherwood district.—In 1912 this district produced 311 tons of lead concentrates and 4,623 tons of blende concentrates more than in 1911 and retained fifth place amongst southwest Missouri districts. The output of lead concentrates in 1912 was 952 tons, valued at $51,953, and the output of zinc blende concentrates was 17,226 tons, valued at $857,883. The percentage of concentrates in the "dirt" milled was higher than in the other Missouri districts. The active development which commenced late in 1910 continued throughout 1912. No similar area in Missouri was as actively explored with drills. Many new concentrating plants were built and operated and others were under construction. The ore being located at comparatively deep levels in very soft ground made shaft sinking and the opening of the mines a work requiring extra care and time. Many new mills will be erected in 1913, and the district should again show an increased yield. The tract having the largest production was that of the Mexico-Joplin Land Co., but the Sitting Bull was the largest single producing mine in the district and one of the largest in the Joplin region. This mine, which is on the Brinkerhoff land, was originally opened by J. M. Short in 1910. A shaft was sunk 189 feet in very soft ground and a 200-ton concentrating plant was built. The mine was one of the remarkable discoveries of the year and was responsible for much of the development in the district. Another shaft was sunk in 1912, and the grade of the concentrates produced improved. Large as the production of the Sitting Bull was in 1912, it was very little more in quantity and was less in value than the output of the Pocohontas mine on the Murphy land. The ore taken from the 196-foot level of the Pocohontas averaged about 9 per cent in concentrates and was treated on a 200-ton concentrating plant.

The other producing mines on the Brinkerhoff land were the Beatrice Bee and the Mary E., a sublease of the Galena-Joplin Lead & Zinc Co. The Mary E. has a 156-foot shaft and a new 200-ton electrically operated concentrating plant, built in 1912.

The Mexico-Joplin Land Co. owns 560 acres of land, upon which many new lessees were working. The depth of mining varied from 145 to 200 feet, and three new plants were built in 1912. Seven concentrating plants of 150 tons capacity each were operated in 1912 and

one was being erected. The largest producer on the tract was the Mary C. Mining Co., which is equipped with a 150-ton mill. Other producers on the Mexico-Joplin land were the High Tariff, with a 162-foot shaft and a 150-ton mill, the Big Western, Rain In Face, Rich in Ore, Mohawk, Shiney Bill, Blue Jay, Bull Durham, Valentine, and Emma A.

A large part of the output from the land of the Hancock-Connor Realty Co. came from the Jungle mine. The only concentrating plant on this tract is one of 200 tons capacity at the Jungle mine. Seventy acres of the tract were leased and being developed by the Thornton Mining Co., the Silver Lake Mining Co., and other lessees.

The Billiken lease on the Chapman, Lennan & Carter land was operated by the Modoc Mining Co. by means of two shafts. The 250-ton concentrating plant made a good production of sphalerite and the largest production of galena in the district.

The Snapp land was purchased by the Sheridan-Adams Royalty Co.; many leases were granted, the ground was well drilled, and many new shafts were sunk. A large part of the 1912 output from the land was by the Old Bacon Mining Co. and Coats & Ortt, sublessees of the 10 Per Cent Prospecting Co. There were 12 shafts ranging in depth from 75 to 172 feet in operation in 1912. Only one 125-ton concentrating plant and hand jigs were operated, but several others are to be erected. The Betsey Jane Mining Co. built a 100-ton mill on the Freeman & Lloyd land, which was operated the last three months of 1912. The output of high-grade sphalerite was good for the period the mill was run. The only producing mine on the Excelsior Lead & Zinc Co.'s land was the Alberta Mining Co. operating a 150-ton plant. The Wild Irishman mine and mill on the Rusk land was worked for a portion of the year. The first lease held by the Little Israelite Mining Co. was purchased by the Durston Mining Co. late in the year, and the Wild Irishman mill was moved to ground on which another run of ore had been located.

After making a good output during 1912 the 100-ton concentrating plant of W. H. Yankie, on the Davis land, was burned in December. The Oak Hill Mining Co., on the Missouri Hills Zinc Co.'s land, and the Dutchman's Dream mine, on the Alhambra Land & Mining Co.'s land, both made small outputs by means of hand jigs and will be equipped with mills. The Waneta Pearl Mining Co., on the Clark land, purchased the old Cherokee mill and will rebuild it on their lease.

At the following mines development work was done and small outputs made by means of hand jigging: Lagonda Lead & Zinc Co. on the Dixon land, Francis T. Mining Co. on the Phillips land, Revenue Mining Co. on the Connor-Pitcher land, Heather Mining Co. on the Taylor land, and the Alhambra Land & Mining Co. on the Starr land. The Napoleon Mining Co. in sinking a 138-foot shaft and driving drifts on the Perry land took out large quantities of cog lead and developed a good ore body. The erection of a concentrating plant was started in November, and no lead or zinc concentrates were sold until January, 1913.

Spring City-Beef Branch district.—The production of all classes of zinc and lead concentrates in this district increased in 1912, and the total value was $63,486 in excess of that of 1911. There was a distinct revival in mining development, old properties were re-

juvenated, and new lands were prospected outside of the former proved mineral area. Fair prices for zinc and lead concentrates in 1913 will result in a further increase in output. The production of galena concentrates in 1912 increased 41 tons, that of lead carbonate 143 tons, that of sphalerite 4 tons, and that of zinc carbonate and silicate 774 tons. Over 50 per cent of the galena and 74 per cent of the blende concentrates was reported by lessees on the Adam Scott lease of the McCown land. The producing mines of this land were the Delta, Platta, and Slick Rock. The ore was hoisted from levels of 100 to 180 feet, and there were two concentrating plants in operation most of the year. The Delta mine, from which Creech & Co. made a large output of concentrates, was sold to Watson & Co. At the Slick Rock mine, in addition to rebuilding the mill, a new shaft was sunk northwest of the mill, opening a good body of ore.

The Sunrise, Lone Hickory, and Fairview mines, on the J. W. Allen land, made the largest tonnage of carbonate and zinc silicate concentrates, in addition to the second largest output of galena and zinc blende. The shaft at the Sunrise was down 148 feet and a 100-ton mill was operated. This lease was purchased by the Minor Heir Producing Co., a new shaft sunk 170 feet, 2,000 feet of drilling done, the underground workings extended, and electric hoists installed. The Sunrise mill has a capacity of 250 tons. At the Lone Hickory two shafts were operated, the deepest of which was down 80 feet. The output, which was entirely of zinc silicate, was treated on a small concentrating plant erected in 1912.

The Onondaga Mining Co., the only other producer of zinc blende in the district, purchased a portion of the Bittick land, sunk a 180-foot shaft, and built a 200-ton concentrating plant in 1912. The only production on the Bales land was zinc silicate from the Gingrich lease. One of the new producing properties was the Sabbath Mining Co. on the Garner lease of the J. M. Cooper Mining & Milling Co. Hand jigs were used to treat zinc silicate ore from workings between the 75-foot and the 100-foot levels. One of the largest producers of zinc silicate was the T. J. McKinney lease on the Hoge land.

Nearly all the lead carbonate concentrates and some zinc silicate was obtained by lessees of Jack & Braun on the Clark Craycroft land. Several lessees on the St. Paul Mining Co.'s land shipped zinc silicate concentrates and much prospect drilling and development was accomplished. The ore bodies are at depths ranging from 65 to 110 feet, and two shafts were worked in 1912.

Other producers of lead carbonate or zinc silicate were The Georgia Mining Co. on the Beckwith land, B. D. Mowry on the Weymann land, and the Craycroft leases on the Leake and Zeta lands.

Springfield district.—A large part of the production given in the Missouri table for 1912 for the Springfield district represents the output of the Bray Mining & Milling Co., located on Pierson Creek, 5 miles southeast of Springfield. This company reopened the Daisy mine in the latter part of 1910 and operated it steadily during the years 1911 and 1912. The new 110-foot shaft, on the same opening which has produced ore since 1906, was used to hoist ore. The ore deposits are in channels mixed with gumbo and in sheets in the roof, which is blue shale. The "dirt" or ore was dressed in a 75-ton concentrating plant and yielded about 8 per cent of concentrates. The

average metal content of the galena concentrates recovered was over 80 per cent and the average zinc content of the blende concentrates was between 63 and 63.5 per cent, with very little iron. The old Badger mine, which has a shaft 258 feet deep and a 50-ton mill, was acquired by the Choteau Mining & Land Co. The mine was unwatered, the shaft retimbered, and the mill rebuilt and enlarged to a capacity of 85 tons. The mill was operated for a part of 1912 and produced a quantity of very high grade sphalerite concentrates.

A shaft was sunk by the Clark Mining Co. which showed ore from the 66-foot to the 80-foot levels, but no production was made in 1912.

The output of sphalerite concentrates in this district almost doubled that of 1911 and the value of the concentrates increased over $60,000.

Spurgeon-Seneca district.—The total value in 1912 of the lead concentrates produced in this district was $32,086, a decrease of over $20,000, and the total value of the zinc concentrates was $30,527, an increase of almost $20,000 when compared with 1911 figures. Only seven southwest Missouri districts produced more lead than the Spurgeon-Seneca district in 1912.

Most of the output of zinc blende came from the Moseley and Quaker Maid mines. The Moseley mine was reopened by the Moseley Valley Mining Co. and the new 200-ton mill was operated part of 1912.

The Estawawa, Goodwin, and Henderson leases on the Granby land were very small producers.

The old De Masters 75-ton concentrating plant on the Aylor-Olson land was remodeled by the Owl Mining Co., the old workings were cleaned out and deepened, and new ground was opened up. The 1912 output was small, because operations were not commenced until November. The old Quaker Maid mine, on the Bucklin-Wills land, was reopened and made a good output. The mill on this ground has a capacity of 100 tons and the two shafts used are about 100 feet deep.

The R. Milne lease on the Newman land was worked by Vader & Co. and other sublessees. Some zinc concentrates of good grade were shipped and the developments indicate an increased output.

The largest producer of galena and lead carbonate was the First Chance Mining Co. on the Davenport land. The ore was hoisted by means of three shafts from levels ranging from 20 to 100 feet in depth. No zinc concentrates have ever been shipped from this mine. Carter & Co. also shipped lead concentrates from ore mined on Davenport land. The Silver Dime Mining Co., on the O'Neill land, was also a shipper of lead concentrates. A 100-foot shaft was in operation and the ore was concentrated by means of hand jigs. There was no output on the Becker land, which was sold to L. F. Hatcher, though some development work was done.

Other producers of lead or zinc concentrates were Robert Neece & Co. on the Miller land, The Lynette Mining Co. on the Gallemore land, and the Ozark Mining Co. Most of the output on these tracts of land was of galena derived from shallow workings.

Stotts City district.—There was no new work of any importance done in this district, and the production in 1912 was about one-third of that of 1911. The largest producing property was the Gundling mine, leased to the American Zinc, Lead & Smelting Co. The ore body is opened by two shafts, one of which is 300 feet deep and the other 230 feet deep. The only other producing property was that of the United Iron Works Co.'s lease, on the Stott land, from which some production

was made by milling tailings. No shafts were operated on the Stott land and all the mines in the camp were idle at the end of 1912. The various mining properties were purchased by Emery Hill.

Wentworth district.—The value of the production of zinc concentrates in this district increased from $19,885 in 1911 to $86,673 in 1912, and there will probably be another increase in 1913. No lead concentrates were sold. Only 8 tons of zinc silicate were produced in 1911, but 376 tons were shipped in 1912, and the production of sphalerite concentrates increased likewise from 485 tons in 1911 to 1,480 tons in 1912. Most of the production was made by the Wentworth Land & Mining Co. and the Bluebell Mining Co., operating on the Bowen lease.

The Alice Dayton mill of the Wentworth Land & Mining Co. has a capacity of 100 tons per 10-hour shift, and the mill of the Bluebell Mining Co., erected in 1912, has a capacity of 200 tons. The shafts at these mines are 72 feet deep, and the ore body is 75 feet wide and 9 feet high. Nine drill holes on the Alice Dayton 20-acre lease are reported to indicate a continuation of the ore body for a distance of about 800 feet.

A large recovery of zinc silicate was made on the Lange & Carnes lease of the Poland land. The ore was taken from the 90-foot level by means of two shafts and treated by hand jigs.

Wetherill district.—The only mines in this district in Howell County are the Rex, G. & C., and the Alice mine of the Empire Zinc Co., near Wetherill post office. The Alice mine had a large output in 1912. The ore, which is carbonate of zinc carrying limonite, crops out at the surface and is worked down to a depth of 60 feet in a large open pit; there is ore still showing in the bottom of this open cut. The zinc carbonate is cleaned in a log washer having a capacity of about 150 tons per 10-hour shift, which was operated from May until December in 1912.

Webb City-Carterville-Prosperity district.—This district includes most of the original and typical "sheet" ground territory, and the high prices paid for zinc blende concentrates during 1912 caused an increase in the output when compared with that for 1911. Only a very small percentage of the district production is derived from "soft" ground, and the prominence of the "sheet" ground mining is indicated by the fact that about 80 per cent of the total production of crude "sheet" ground ore came from this district. The recovery of galena concentrates in southwest Missouri from ore mined in "sheet" ground was 25,056 tons, of which this district produced 22,385 tons. The quantity of zinc blende concentrates in southwest Missouri derived from ore mined in "sheet" ground was over 117,955 tons, or nearly one-half of the total zinc blende output of the entire State, and of this large quantity the "sheet" ground mined in the Webb City-Carterville-Prosperity district yielded about 94,570 tons. The recovery of galena and zinc blende concentrates from crude ore averaged only 2.6 per cent in 1910, 1911, and 1912. Many of the mines operated double shift, and on the whole operations showed a large increase.

The production of lead concentrates in 1912 was 24,115 tons, or 511 tons less than in 1911, and the value decreased $47,366. The production of zinc blende concentrates in 1912 was 101,618 tons, an increase of 8,156 tons when compared with that of 1911. The total

value of the concentrates sold was $6,522,781 in 1912 and $5,114,784 in 1911.

The Davey tract of the American Zinc, Lead & Smelting Co. produced the largest output of galena concentrates and the second largest production of blende concentrates in 1912. The lead concentrates amounted to 24 per cent and the blende concentrates to 14 per cent of the entire district output. The Davey mines, Nos. 1, 2, 3, and 4, are in the vicinity of Prosperity, and are equipped with four double-compartment shafts from 225 to 250 feet deep and four concentrating plants having a combined daily capacity of over 3,500 tons. The power used at the plants was changed from steam to electric, and a new plant was erected to treat slimes from Davey No. 3. Tailings from the Hockaday tract belonging to the same owners were milled at a 100-ton plant, and the Silver Dick mine was leased to the Minor Heir Producing Co. by the Vantage Extraction Co. The production from the Richland tract was small in 1912. B. T. Becker was engaged in pumping the water from the underground workings, which were flooded all the year. The shaft on the Richland tract is 163 feet deep, and there is a 200-ton mill on the land.

The American Zinc, Lead & Smelting Co. also operated the Endeavor mine on the Chinn land.

Lessees on the Guinn land reported the largest output of zinc concentrates in the district. The capacity of the 12 concentrating plants on the land was in excess of 4,000 tons per day. The leasing companies that produced in 1912 were as follows: Electrical Lead & Zinc Mining Co., American Canadian Mining Co., Hurry Up Mining Co., Mercantile Metal Milling Co., Osceola Lead & Zinc Co., Realization Royalty & Investment Co., Rhea Lead & Zinc Co., Mutual Lead & Zinc Co., Ground Floor Mining Co., Show Me State Mining Co., J. P. Royalty & Mining Co., Mont B. Mining Co., Moark-Nemo Mining Co., Daniels Bros., and Walker & Co. One of the largest producing companies on the Guinn land was the Mercantile, which operated mills Nos. 4 and 5, each of 250 tons capacity, and mill No. 1 of 200 tons capacity. The Electrical mine and 150-ton mill were leased to the Incline Mining Co. during the year. The Schoenheuer-Walton Mining Co., a sublessee of the Rhea lease, made one of the largest outputs on the tract.

The lessees of the Center Creek Mining Co. in the territory between Webb City and Carterville were the third largest producers of zinc concentrates. The principal producing lease on the Center Creek Mining Co.'s land was that of S. Y. Ramage, who hoisted ore through 2 shafts and milled it on 2 concentrating plants, having a total capacity of 550 tons. This lease (Morgan 40) has been one of the largest producers in the district for many years, and the mining plant is modern in every respect.

Other producers on Center Creek land were the Laura Alice Mining Co., Rogers Miller Mining Co., Pacific Sludge Co., Pioneer Mining Co., and Spotted Dog Mining Co. A new 100-ton tailing mill was erected on the land in 1912. About 20 shafts were in operation, and the 9 concentrating plants had a combined capacity of 1,500 tons.

The lessees of the Bradford Kansas City Mining Co. in the same locality as the Center Creek mines also reported a large production. The sublessees were the Dinger Mining Co., Empress Mining Co., Lancaster Mining & Milling Co., and the Two Bills Tailing Co. Two

shafts were worked and the ore was milled on 3 plants each of 300 tons capacity.

The Continental Zinc Co. and its lessees produced large quantities of both lead and zinc concentrates from the Litteral tract at Prosperity. One shaft and a 300-ton mill were operated steadily throughout the year. The Lucky Budge, Dominion, Fluorine, Ruby D, and Avondale leases on the Prosperity 40 of Ben C. Aylor were also very productive. A new mill was erected by the Fluorine Mining Co. Altogether there were 5 concentrating plants on the lease having a combined capacity of 1,100 tons.

The production by lessees of the Connor Realty Co. was considerably larger in 1912 than in 1911. The producing mines on the property in 1912 were the Dixie, Katie C., Lima, Sara, McKinley, Federated, Croesus, Manhattan, Grey Wolf, and M. & N.

The Ashcraft land was worked by The Providence Mining & Milling Co. Many improvements were made to the mining plant and the production was large. A 200-horsepower motor was installed in place of steam power in the Providence mill. This mill has a capacity of 300 tons and the South Portland mill a capacity of 150 tons.

Many of the large "sheet" ground mines are directly north of Webb City. A large proportion of the production for the district came from leases on the Kelly, Bowman, Scott & Ware, Newell Morse Royalty Co., Byrd, Baker, Pike Land Co., Rochester, and Underwriters Land Co. properties. Among the producers on the Kelly land were the White Dog, Osceola, and Mineral King mines, and a new 300-ton mill was under construction at the Imperial mine. Very few properties produced more lead and zinc concentrates in 1912 than the Bowman, Scott & Ware land, on which are situated 3 mills having an aggregate capacity of about 700 tons. The large producing mines were the Wingfield, Edmund Lyon, and Herbert S.

The producing leases on the Newell Morse Royalty Co.'s land were the Athletic Mining Co. and the Bertha A., a sublease of the Winslow Mining Co. Considerable drilling was done by the Athletic Mining Co. and a 100-ton sludge mill was erected.

The output of concentrates on the Byrd land came from the Goode, Old Dominion, Charleston, Morning Star, and Black Locust leases. The production from the Gibson, Nowata, and other mines on the Pike Land Co. was not as large as in former years. A new tailing mill was built by the Mary Milling Co. The principal outputs from the Rochester land were made by the Coats & Ortt, Golden Glow, Yellow Dog, and After Glow mines. The Underwriters Land Co. fee and their lease of the Worthington land yielded a large quantity of both lead and zinc concentrates. The Vantage Mining Co.'s lease on the H. M. Baker land was operated by the Vantage Extraction Co. and sublessees. A good production of concentrates was made. The Minor Heir Vantage Mining Co. made extensive improvements to the 200-ton mill on the land and constructed a tramway from the mill to the bottom of a large open cut caused by the caving of the old workings.

The Carter land, formerly leased to the St. Paul Mining Co., was acquired by the George M. Mining Co. Only a small output was made in 1912, but the mining plant was overhauled and many improvements were made. The Culpepper mine and 350-ton mill on the Cunningham land was taken over by the Dexter Mining Co.

and the "sheet" ground was worked by means of one 160-foot shaft. The Sunflower Lead & Zinc Co. on the Smith land also mined "sheet" ground.

Other shippers of concentrates in 1912 were the Boston Get There Zinc Co., Jim D. Mining Co., Last Chance Mining Co. (Chinn land), Maude H. Mining Co., and Hound Dog Mining Co. (Dougherty Davey land), Gobbler Mining Co. (B. C. Aylor), Little Daisy Mining Co. (Lewis land), Missouri Zinc Fields Co., Prosperity Milling Co. (Troup 40), and lessees of the Reagan land.

Zincite-Smithfield district.—The mines in this district include those in the territory from south of Zincite along the westerly border line between Missouri and Kansas to Smithfield. The production of zinc concentrates in the southern portion of the district increased slightly in 1912, but the opening of two new mines in the northern end of the field increased the shipments of sphalerite from 1,964 tons in 1911 to 4,716 tons in 1912.

The Yellow Jacket Mining Co. on the McBee land developed one of the richest ore bodies located in the Joplin region in 1912. The company sank 2 shafts to the 90-foot level in very "soft ground" and erected a 200-ton electrically equipped concentrating plant. Although the mill only commenced operating in April, 1912, a large output of blende concentrates was sold. The concentrates ran about 62 per cent zinc content and were practically free from iron, lead, or lime, and in consequence brought $2 per ton over the high basis price current for sphalerite concentrates. Numerous drill holes have been sunk on the lease, which would appear to indicate an extensive ore body. The mine is on low ground and some distance from other producing properties. The successful operation of the Yellow Jacket mine caused an active drilling campaign in the bottom land on both the Missouri and the Kansas side of Spring River. This resulted in the development of the Yellow Pup mine on the McKee land on higher ground south of the Yellow Jacket mine. The ore at the Yellow Pup mine is in harder ground and contains some galena. The zinc concentrates recovered are of good grade, but inferior to the sphalerite from the Yellow Jacket mine. The shaft at the Yellow Pup mine is 80 feet deep, and a 200-ton electrically operated concentrating plant was erected and operated for several weeks in 1912. The results of the milling were very satisfactory.

The old Lincoln mine, at Smithfield, operated by the Aberdeen Mining Co. and the 125-ton mill were run steadily, making a good output of high-grade concentrates.

The Minor Graham Mining Co., lessee of the Parkinson, Graves & Harper land and of the 150-ton mill at the Clara Belle mine, was the largest producer in the southern part of the district. The only productive lease on the Belleville Land & Mining Co.'s property was the Dorothy Marie. Some mining was done on the Atgate lease of the R. F. Brooks land.

On the Wyssbrod land the producers were the Daylight and the Huckleberry mines. The two 100-ton mills were operated intermittently and the ore treated came from between the 80-foot and the 90-foot levels. The small output on the land of the Geneva Mining & Leasing Co was made by scrappers.

The L. C. Moses Mining Co., a sublease of the Missouri Standard Mining Co., made a good production by means of hand jigs from a mine on the Leckie land.

The United Zinc Co.'s lease on part of the Leckie land expired early in 1912, and the Kidd Mining Co. leased the property and erected a 100-ton concentrating plant, which made a good output of zinc concentrates.

Other small producers were Lee Holden on the O'Keefe land and the Seven Mining Co. on the Capitalista Mining Co.'s lease of the Sansome land.

CENTRAL AND SOUTHEAST MISSOURI.

The ore deposits of central and southeast Missouri reach in a more or less connected belt from the region of Benton, Pettis, Morgan, Moniteau, Cole, and Miller counties on the northwest to the northern and eastern flanks of the St. Francis Mountains on the southeast. It is also true that there are scattered areas where more or less mining has been done all the way between the northwest end of this belt and the Joplin region, so that strictly speaking the lead and zinc deposits of Missouri practically form a zone around the northern half of the Ozark dome.

The deposits in the counties named above, corresponding to the central Missouri region, are of the general type of those in the Joplin region, in that the ores consist of galena and sphalerite, or the oxidized derivatives of those minerals, and occur in association with solution breccias and sink-hole shale patches, the ore being found in the Cambrian and Ordovician dolomites and included cherts and occasionally in the Pennsylvanian shale. The occurrence of ore in crevices or thin vertical sheets is very common, but practically all the production of ore has been obtained from sink-hole breccias or "circles," a form of deposit noted as also important in the southwest Missouri area.

The southeastern part of the belt, in the vicinity of the St. Francis Mountains, forms the disseminated lead region of southeast Missouri. The southeast Missouri deposits have been known and worked for about 200 years. The earlier workings were shallow, and even yet considerable shallow lead is raised, generally in connection with the mining of barytes, or "tiff," as it is locally known. The mines in the disseminated lead region range from 100 feet to about 550 feet in depth, depending on the depth from the surface to the basal portion of the Bonneterre limestone.

The ore deposits now worked are almost wholly in the lower part of the Bonneterre limestone, where they occur in disseminated form over large areas, relatively richer in the vicinity of the intersecting crevices and joints. The crevices show little if any displacement, and there are no breccias of consequence. The copper, nickel, and cobalt in Madison County occur with galena and marcasite in blanket formation in the carbonaceous beds of parting at the contact of the Bonneterre limestone with the Lamotte sandstone below, and in the vicinity of the intersection of this contact with the sloping surface of the pre-Cambrian rocks. Both the Bonneterre and the Lamotte formations are of Cambrian age.

Prospecting is done by means of the diamond drill, and extensive campaigns of drilling have been prosecuted in the vicinity of all the important producing tracts. Just before the business depression in 1907 there were about 100 diamond drills actively engaged in prospecting. In 1908 and 1909 very little drilling was done other than that necessary in mining. In 1910, 1911, and 1912 drilling became somewhat more active and several tracts were prospected.

The diamond drill is also used in mining as an aid in following the ore. Cores are taken from the heading in various directions, straight ahead, at angles upward, downward, or to the side, and from these cores the direction to drive the heading is determined.

The ore in the southeast Missouri region is almost wholly lead, although a considerable zinc deposit occurs at Valle mines, some 6 miles north of the Bonneterre district. A certain percentage of zinc is also found in the disseminated lead ore, the ore from one shaft being reported to run occasionally as high as 2 per cent of zinc for a week at a time. The zinc occurs more plentifully in the Leadwood-Flat River districts, and may lie near the contact of the Bonneterre limestone with the Lamotte sandstone or some distance above it. In the lead concentrates zinc ranges from 1 to 5 per cent or more. In the maximum proportions mentioned the zinc makes trouble in lead smelting, and for this reason some of the concentrating plants remove the zinc as a table middling. As the quantity of zinc is increasing, it will no doubt before long become a salable product of the district. In one mill now operating, middlings, containing 20 per cent of zinc, are being discarded at the rate of a ton daily. An interesting feature of the zinc middlings is that they carry a disproportionately large part of the silver content of the ore, the silver being apparently associated with the zinc rather than with the lead.

Copper, nickel, and cobalt also occur in the ore, in greater quantity in the vicinity of Fredericktown, and in small quantity, irregularly, in nearly all the deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district, and in some instances has been a source of income.

The lead ore of southeast Missouri carries a small proportion of silver, the average being a very little over 1 troy ounce to the ton of lead concentrates. The resulting pig lead likewise carries silver, together with a little copper, nickel, cobalt, and traces of antimony and arsenic, and is sometimes commercially known as "Missouri chemical" lead in contradistinction to "Missouri soft" lead from the Joplin region. An average of about 15 per cent of the total lead concentrates from southeast Missouri is desilverized. The silver so recovered does not pay for the refining charges, but the desilverized lead commands a slightly higher price, making up the difference. As the silver content of the concentrates is so small it is disregarded in their sale, and therefore the smelter reports are relied upon for the silver production. As explained already, the quantity of silver produced during any year bears no direct ratio to the quantity of silver-bearing lead concentrates smelted during that year, for the reason that the silver bullion is stored and refined in batches at convenient times.

The silver production of southeast Missouri was 35,438 fine ounces in 1912 as compared with 49,867 fine ounces in 1911, with 33,096 ounces in 1910, with 14,188 ounces in 1909, and with 49,131 ounces in 1908. The silver production of 1912 was recovered from 31,183 tons of lead concentrates, that of 1911 was recovered from 51,109 tons, that of 1910 was recovered from 35,002 tons, that of 1909 from about 31,000 tons, and that of 1908 from 26,488 tons.

The crude lead ore mined in 1912 amounted to 4,064,366 short tons, against 3,974,712 tons in 1911. The crude ore in 1912 yielded 5.3 per cent of lead concentrates which averaged 67.1 per cent of lead. The average value per ton of the lead concentrates in 1912 was $45.01, as compared with $46.94 in 1911, and the concentrates were slightly lower in lead content than in 1911. The output of galena concentrates decreased from 219,145 tons, valued at $10,293,400, in 1911, to 218,803 tons, valued at $9,849,854, in 1912. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are arbitrary to a certain extent. The lead concentrates produced in the southwest Missouri region are mainly sold on bids from various purchasers and the lead concentrate prices are not comparable with those given for the disseminated lead district.

REVIEW BY COUNTIES.

Pettis County.—The Camilla Mining Co., on the Chester Realty Co.'s land in sec. 27, T. 44, R. 20, Pettis County, sold a quantity of galena concentrates. The ore deposit is in limestone with a spar gangue, the lead content being much greater than that of zinc. Most of the work done was in sinking the two shafts, in opening drifts, and in building a 200-ton mill. The Camilla has a 35-foot face of ore at the 100-foot level, and drill holes show a lower run of ore at 215 feet.

Benton County.—The Tahoma Mining Co.'s mine, which has a shaft down 225 feet, was idle in 1912.

Cole County.—The Black Jack Mining Co.'s mine was idle in 1912. Much of the work was confined to experiments conducted with a view to obtaining a process for cheap and clean separation of zinc blende from barytes. Reuben Cole, of Russellville, shipped some galena recovered from 5 shallow shafts, the deepest of which was down 16 feet.

Franklin County.—The Wrisberg Mining & Milling Co. made no shipments of concentrates in 1912 pending the completion of a 100-ton concentrating plant. The shaft is 100 feet in depth, and the ore body, apparently a crevice deposit, is reported to be developed for a distance of 600 feet both north and south from the shaft. A crosscut is reported to intersect another crevice deposit at a distance of 392 feet.

Moniteau County.—The Monarch Coal & Mineral Co., of Excelsior, worked a pocket of cannel coal, varying from 42 to 100 feet thick, by means of an open cut 100 feet in depth and a shaft 124 feet in depth. Both lead and zinc concentrates incidentally recovered in the company's coal mining operation were shipped in 1912. Considerable lead and zinc is found chiefly in breccias adjacent

to the coal and shale. The mineralized shale underlying the coal was not developed. Inadequate railroad facilities handicapped the coal output and restricted the production of lead and zinc. The company reports that the concentrating plant needs to be enlarged and remodeled to effect a better separation of the ore from the coal and shale gangue.

Washington County.—Several companies owning large tracts of land in Washington County, such as the Washington Land & Mining Co., the Southeast Missouri Lead Co., the Parole Mining & Mercantile Co. (successors to the Renault Lead Co.), work their property on a royalty basis. The ore which occurs at shallow depths and in association with barytes is mined in a small way and at odd times by the barytes miners. This ore is all hand picked and cleaned, there being no concentrating plants. There are numerous other shallow lead and barytes diggings scattered over Washington County which are worked by small operators and farmers, who sell their product to the country merchants and to ore buyers. Much of this ore was purchased by James Long, of Potosi, Higginbotham & Sons, of Fertile, and Buren Duckworth, of St. Claire.

Bugg, Eversole & Towl, of Potosi, mined some galena through a 65-foot shaft. The Washington-Wayne Mining Co., leasing on the Flat River Mining Co.'s land, did considerable drilling with diamond and churn drills and sunk one shaft. Its output of lead concentrates in 1912, however, was small.

Jefferson County.—The Valle Mining Co. also operates on a subleasing or royalty system a large tract of land in Part of St. Francois County. The ores are galena and zinc carbonate and are found at depths ranging up to 225 feet, depending on the topography. There were 12 shafts in operation in 1912, and a good production of ore was made. On the tract there is a Scotch hearth lead furnace which has not been operated for several years and a kiln in which the zinc carbonate ore is calcined before shipment.

The following section of drill hole No. 1, about three-fourths of a mile nearly due south of Valle mines station, as interpreted by the Missouri Bureau of Geology and Mines, has been furnished by the Valle Mining Co.:

Section of drill hole No. 1, Valle mines, Jefferson County, Mo.

	Feet.
Surface	9
Potosi	227
Derby and Doe Run	94
Davis shale	170
Bonneterre	240
Total depth	740

St. Francois County.—During the year 1912 the St. Joseph Lead Co. operated 5 hoisting plants continuously, 2 at Bonne Terre and 3 at Leadwood. The plant at Flat River, known as shafts No. 8 and No. 15, was temporarily closed in August, 1912, only the pumps being kept going and other work necessary to start the mines on short notice.

A drift from mine No. 7 to the main working at mine No. 1, Bonne Terre, was completed, permitting the establishing of underground haulage and the abandonment of the independent hoisting plant

at mine No. 7, the hoisting plant at No. 1 being of sufficient capacity to handle the output of both mines.

The two concentrating plants, the No. 1 mill at Bonne Terre and the No. 2 mill at Leadwood, were operated the entire year, the tonnage crushed averaging about 3,000 tons of crude ore in 24 hours. Mill No. 1 is being remodeled; one Hancock jig was placed before the close of the year, and it is expected that all the Parsons and Hartz jigs will be removed and Hancock jigs substituted for them. The mill is also being fully equipped with Wilfley tables.

The power plant at Leadwood has been improved by the installation of one 1,000-kilowatt low-pressure Curtis steam turbine engine and one 1,000-kilowatt high-pressure Curtis steam turbine engine, which are expected to be in operation during the greater part of the year 1913. This power plant, with the producer gas engine plant at Bonne Terre, is designed to furnish sufficient electric current to operate all the mines and mills of the company.

The smelter at Herculaneum has been improved by changes in blast furnace charging tracks, by increase in capacity of furnaces, and by various minor alterations and additions. The construction of a bag house, with dust chamber and fume pipes connecting all blast furnaces and sintering machines with the 350-foot brick stack, was begun during the year; the fume pipe and dust chamber will be ready for taking care of all the fumes by May 1, 1913, and the bag house will be completed during 1913.

The Doe Run Lead Co. operated 6 shafts in the Flat River district, 1 shaft being 2 miles south of Doe Run.

Two mills were in operation—No. 3 mill at Rivermines, with a capacity of 2,500 tons per day, and mill No. 1 at Doe Run, with a capacity of 1,000 tons per day. Mill No. 1 was, however, shut down permanently November 1, 1912. Mill No. 3 is being enlarged so that it can handle a total of 4,000 tons daily.

This mill is one of the best equipped in the district. The building is of steel construction throughout. The mill machinery is operated by alterating current 440-volt motors, which receive their current from the central gas-electric power station at Rivermines.

All shaft equipment, such as hoists, compressors, underground pumps, are motor driven.

Four 800-horsepower Snow twin tandem gas engines, direct connected, each with a 600-kilowatt generator, and 1 steam-driven 300-kilowatt generator, furnish power to all shafts and mill machinery. The gas-producer plant has four 800-horsepower Loomis-Pettibone producers and one 1,000-horsepower Westinghouse producer.

The underground haulage at Nos. 1 and 4 shafts is done by air locomotives. At all other shafts mule power is used.

Shafts Nos. 3, 9, and 12 are shut down at present, but will be started again when No. 3 mill addition is completed.

The company increased its production from 32,000 short tons of metallic lead in 1911 to 33,941 tons of metallic lead in 1912.

No copper concentrates were produced in 1912.

The Desloge Consolidated Lead Co. in 1912 operated 3 shafts, 2 of which are each 280 feet and the other 500 feet in depth. Two of the shafts are near the town of Desloge, but No. 4 shaft is near Leadwood. During 1910 the concentrating plant was remodeled and is now equipped with 3 Hancock jigs, 30 Wilfley tables, 10 Frue van-

ners, and appropriate rolls and Chile mills. The capacity is 1,500 tons per day of 24 hours. A large quantity of lead concentrates was produced, a portion of which was smelted in the company's smelter near the concentrating plant. The smelter is equipped with 4 Flintshire-Tarnowitz reverberatory furnaces, 2 hand rabbling reverberatory roasting furnaces, and 1 small cupola blast furnace, with drossing kettles, etc. In recent years none of the furnaces, except 2 of the Flintshire furnaces, has been worked, the "gray" slag being sold to other smelters.

The St. Louis Smelting & Refining Co. has its mines in the vicinity of the village of St. Francois, about 1 mile north of Flat River. Four shafts, ranging from 200 feet to 560 feet in depth, were in operation in 1912. The bottom of the ore was reached in shaft No. 6 at 540 feet and the Lamotte sandstone at 560 feet. The concentrating plant is modern, having a capacity of 2,000 tons per day of 24 hours and being equipped with Hancock jigs, Richards classifiers, Huntington mills, Overstrom and canvas tables, Frue vanners, slime and settling tanks. A central steam power plant drives air compressors and electric generators. The mill, hoists, and pumps are operated by electricity, as well as the underground haulage and the electric trams for handling the ore from the shafts to the mill. This company also operates a lead smelter and refinery at Collinsville, and the lead concentrates produced by the mines were smelted at that plant.

The Federal Lead Co. operated three shafts during 1912, mining and milling therefrom approximately 1,000,000 tons of crude ore. The crushing plant of the company was remodeled and enlarged so that it now has a capacity of 4,600 tons per day of 24 hours. The concentrating plant was also enlarged by the addition of three more Hancock jigs and other concentrating equipment and brought up to a similar capacity. The plant, as now equipped, has 12 Hancock jigs, 72 tables, and 30 vanners arranged in 3 units of 3 sections each; all symmetrically equipped. There are also regrinding rolls, elevators, Esperanza-Federal drag classifiers and, as a supplement to the slime treatment, a canvas plant of 48 by 14 foot canvas tables. During 1912 in addition to the regular lead shipments, a small tonnage of copper concentrates was recovered as a by-product, a roasting-magnetic separating plant being used for the purpose. This concentrate as shipped contained, for the year, 1,346 ounces of silver and 32,534 pounds of copper. No silver was recovered from refining lead. About 4,500 horsepower is used in mining and milling, and is generated largely as a central steam power plant having Green chain stokers under the boilers and Curtis steam turbines for electrical power generation. Electric haulage is used underground. The mines and plants are located in vicinity of Flat River, St. Francois County.

The St. Francois Lead Co. purchased the Alma mine and operated 1 shaft which was 400 feet deep. The mine was developed and two-thirds of a mile of standard-gage railway was built. No concentrating plant was erected as the crude ore will be shipped to the St. Louis Smelting & Refining Co.'s plant at St. Francois.

Madison County.—The Mine La Motte Lead & Smelting Co. operated 3 shafts during 1912 on a tract which was first mined in 1720. The shallow deposits which were first worked were followed down to a depth of 100 to 125 feet, from which level the ore has been coming,

which for 50 years has supplied the mill and smelter. The mill, which is practically new, has a capacity of 500 tons per day of 24 hours. The old 250-ton mill and the 400-ton mill of the Wheeling Milling Co., on the same tract, were not in operation. The smelter has likewise been idle for several years. The attempt was made some years ago to smelt the copper and nickel-cobalt sulphides, which in certain parts of the mines occur plentifully with the lead and are separated in concentration. Of late years these ores have been avoided and attention in mining has been limited to the lead ores.

The Federal Lead Co., during 1912, operated the old Phoenix and also the Fleming property under lease, mining and milling therefrom some 400 tons per day. The mill located at Phoenix No. 1 shaft was remodeled and enlarged so as to handle this tonnage suitably. Coal is hauled in and concentrates hauled out to the Iron Mountain Railroad by motor truck, a distance of 2¼ miles. The ore is low grade and the ore bodies as so far found are not extensive. The property is located some 3 miles north of Fredricktown, in Madison County.

Litigation prevented the resumption of work at the North American mine. The ore formerly mined consists of an intimate mixture of the sulphides of copper, lead, nickel, cobalt, and iron in the form of chalcopyrite, galena, limonite, and pyrite. As reported by the receiver of the property, the metals have the following proportions in the ore: Copper, 2.5 per cent; lead, 2 per cent; nickel, 1 per cent; and cobalt, 0.5 per cent; in all, 6 per cent of metallic content.

OKLAHOMA.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Oklahoma in 1912 is shown in the following table:

Production of lead and zinc in Oklahoma in 1912, by districts, in short tons.

District.	Ores.						Metal content.[a]			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
	Galena.		Sphalerite.		Carbonate and silicate.		Quantity.	Value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.				
Ottawa County:										
Miami	4,256	$231,628	10,258	$405,975	.....	.....	3,387	$304,830	4,783	$660,054
Peoria	.....	.....	.....	.....	90	$2,500	.....	.....	32	4,416
Quapaw	1	50	1,621	78,404	2	50	1	90	844	116,472
	4,257	231,678	11,879	484,379	92	2,550	3,388	304,920	5,659	780,942
Murray County	.....	.....	250	10,000	.....	.....	.....	.....	110	15,180
State total:										
1912	4,257	231,678	12,129	494,379	92	2,550	3,388	304,920	5,769	796,122
1911	3,189	171,357	10,661	330,943	512	11,216	2,501	225,090	5,150	587,100

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal, it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

The following table gives the crude lead and zinc ore for the whole State of Oklahoma, but it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and the Quapaw districts, inasmuch as the character of the ground operated in these districts differs so radically that general calculations for the State would be valueless:

Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1911 and 1912.

	1911	1912
Total crude ore milled in Oklahoma.....short tons..	224,450	293,500
Miami district:		
Total concentrates in crude ore—		
Lead.....per cent..	2.1	2.1
Zinc.....do....	5.6	5.1
Metal content of crude ore—		
Lead.....do....	1.5	1.7
Zinc.....do....	2.8	2.6
Average lead content of galena concentrates.....do....	78.3	79.6
Average zinc content of sphalerite concentrates.....do....	50.4	51.8
Average value per ton—		
Galena concentrates.....	$53.55	$54.42
Sphalerite concentrates.....	$29.50	$39.80
Quapaw district:		
Total concentrates in crude ore—		
Lead.....per cent..	0.4	.....
Zinc.....do....	3.0	1.9
Metal content of crude ore—		
Lead.....do....	.4	.....
Zinc.....do....	1.7	1.1
Average lead content of galena concentrates.....do....	79.3	79.5
Average zinc content of sphalerite concentrates.....do....	57.0	57.8
Average value per ton—		
Lead concentrates.....	$55.32	$50.00
Sphalerite concentrates.....	$36.78	$48.36

The value of the mine production of lead and zinc in Oklahoma for the year 1912 was $1,101,042, compared with $812,190 in 1911. The increased yield of both metals was almost entirely due to operations in the Miami field. The shipments of zinc carbonate and zinc silicate were nearly all from the Peoria district, in Ottawa County, and were less than in the year 1911. Most of the mines in the Quapaw district were idle the greater portion of 1912, and the value of the lead and zinc concentrates shipped from this district declined. The production from mines in the Arbuckle Mountain region in Murray County, in southern Oklahoma, increased very little. The United Mining & Milling Co., the only shipper in the region in 1912, produced a mixed sphalerite and carbonate concentrate from open-pit workings on the Butterly land.

In 1912 the lead concentrates produced in the Oklahoma districts were of slightly higher grade than those shipped in 1911. The average selling price of lead concentrates was 87 cents a ton higher at Miami than in 1911. Both the tonnage of ore milled and the average concentrates contained in the crude ore declined in the Quapaw district. The blende concentrates in the Miami district contained 0.5 per cent less zinc in 1912 than in 1911, and those from the Quapaw district 0.7 per cent less than in 1911. The metal content of the galena concentrates at Miami increased appreciably.

The shipments of both lead and zinc concentrates from Oklahoma were more in 1912 than in 1911. The lead concentrates sold were 1,068 tons more in quantity and $60,321 greater in value than in

1911. The shipments of sphalerite or blende concentrates were 1,468 tons more in quantity and $163,436 greater in value.

The shipment of zinc carbonate decreased from 512 tons in 1911 to 92 tons, and the value was $8,666 less than in 1911.

The entire output of lead concentrates and all but 250 tons of the sphalerite concentrates came from Ottawa County.

The Miami district yielded 84.6 per cent of the sphalerite concentrates and all but 1 ton of the galena concentrates sold in Oklahoma in 1912.

NORTHEAST OKLAHOMA.

The lead and zinc mines of this section form the southwesternmost extension of the ore deposits of the Joplin region. They occur chiefly in chert breccias, but occasionally in limestone and sandstone breccias. The sandstones belong to the Chester group. the cherts to the Boone limestone, and the limestones to either the one or the other, both being of lower Carboniferous age. The ores are galena, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, never containing as much as an ounce of silver to the ton of lead concentrates.

Peoria district.—There was very little mining at Peoria, the site of the first lead and zinc mining in Oklahoma, in 1912, and the output of zinc carbonate was much less than in 1911. The ore was all obtained from shallow shafts, and the district is handicapped by lack of rail transportation.

Quapaw district.—Very few of the mines in this district were operated and others were only worked for a portion of the year. In consequence of this condition, although the average price paid for sphalerite concentrates increased over $11 per ton, the value of the concentrates shipped declined from $100,773 in 1911 to $78,454 in 1912. The quantity of zinc concentrates shipped in 1912 was over 600 tons less than in 1911, and there was practically no output of lead, against 329 tons in 1911. Nearly the entire output of the district was made by the Petersburg Land & Mining Co., and lessees on the Iowa-Oklahoma Mining Co. (Abrams) land.

The Petersburg mill was operated steadily for several months and made the largest production in the district.

The lessees on the land of the Iowa & Oklahoma Mining Co. who produced concentrates were C. E. Miller, the Good Luck Mining Co., and the Katy Lee Mining Co. Four shafts were in operation and ore was extracted from levels at depths ranging from 62 to 90 feet. A 100-ton mill and hand jigs were operated by the lessees.

The White Eagle mine, which has a milling plant capable of treating 250 tons of ore daily and which was the largest producer in 1910, was idle until December, 1912, when it was leased by Thomas Hackwood. Some concentrates milled in 1910 were sold in 1912. The new lessee pumped the water from the mine, and the mill was started early in 1913.

The Falulah mine (old Mission) was leased to M. G. Estabrook late in the year. The mine was unwatered, and the milling system was changed in the concentrating plant, which is of 400 tons capacity. A small output of sphalerite was recovered with hand jigs on the Paul Ewart land, on which the Emma Gordon Mining Co. have first lease.

Miami district.—The mines of the Miami district in 1912 shipped 4,256 short tons of galena concentrates, valued at $231,628, and 10,258 short tons of sphalerite concentrates, valued at $405,975. This shows an increase of 1,408 tons of galena concentrates and of 1,867 tons of sphalerite concentrates when compared with the output of 1911. The total increase in the value of the concentrates was $237,546. The district still maintained a high ratio of concentrates to the crude ore milled. The average of the metal content of the blende concentrates produced showed a slight decrease, but the selling price of both galena and blende concentrates increased over that of 1911. The increase in the price paid for lead concentrates was very small, but the increase in the average price paid for blende concentrates was $10.30 a ton.

The percentage of galena in the crude ore increased. The recovery of galena concentrates averaged about 1 ton to 2.5 tons of sphalerite, which is considerably higher than in any other district in the Joplin region. Both the galena and the sphalerite concentrates marketed in 1912 contained a larger metallic content than in previous years. The increase of about 50 per cent in the value of concentrates is gratifying, but a more notable result is that development showed in many mines in the southern portion of the camp a lower run of ore equal to, if not better, than the upper run now nearly worked out in many of the older mines. The completion of new concentrating plants in both north and south sections of the district and extensive drilling on many leases are certain to result in a much increased yield in 1913. The mines in the northwestern part of the district are working on the same ore body first located in the southern part of the camp. This run of ore dips to the north, and is there worked at a much lower level. The operation of the large pump at the Chapman & Lennan property lowered the water level and enabled the mines to the south to open up the lower run of ore.

The ores are galena and sphalerite in the proportion of about one of the former to three of the latter, no oxidized ores having yet been found. The upper run of ores, as worked in previous years, occurs at a depth of 90 to 130 feet in sandstone breccias and in flint breccias lying below the sandstone; but as this run is followed north it rapidly descends, and in recent openings is from 230 to 250 feet in depth. The sandstone in the older and shallower mines was impregnated with a heavy oil, which, evaporating to asphalt, caused much trouble in saving the concentrates, by balling up the ores on the jig beds and tending to float off the finer particles of ore. The oil also operated to lower the grade of the concentrates by enveloping them in films of carbonaceous matter and so causing finely powdered marcasite and pyrite to stick to them.

As mining developments in the upper level worked away from the territory first opened in the southern part of the field and as the deeper level was opened up in the original district, it was found that the oil became much less plentiful.

The main ore body worked up to the latter part of 1911 had the form of a long straight run, bearing about N. 30° W. and reaching from the Sunny Jim mine on the southeast to the Emma Gordon mine on the northwest, a distance of 4,300 feet, and shown by the drill to extend at least 2,500 feet in a more northerly direction be-

yond the Emma Gordon mine, a total known length of about 1¼ miles. Throughout this distance the ore body is in a sandstone breccia, with shale overlying, though at places in the run stopes have been taken up in the underlying chert breccia. The width of the run varies from 75 to 150 feet, and the height from 8 to 13 feet, ranging up to 25 feet where the lower stopes have been taken up. Several other ore bodies have been opened to the west of this run which have their elongation parallel to the run, but none of these as at present developed are at all comparable to the main run in extent.

North and slightly west of the old workings on the Emma Gordon lease are situated the mines of the Oklahoma Lead & Zinc Co., the Carson-Dodson Mining Co., the Thirty Acre Mining Co., and the Haymaker Mining Co. Other ore bodies follow a northeasterly course across the subleases of the Prairie Mining Co. on the Emma Gordon land and the Chapman & Lennan leases on the Emma Gordon and the Miami Royalty lands. Drill holes sunk in 1912 are reported to indicate the extension of the northeasterly run several miles toward the Kansas State line, but no ore was hoisted in 1912 from any shafts northeast of the Chapman & Lennan lease.

In former years most of the ore was derived from the upper run of ore, which varied from 90 to 130 feet in depth. By the end of the year 1911 much of the ore between these depths had been exhausted in many of the mines, and an increased proportion of the ore treated in 1912 was taken from a lower run of ore below 200 feet. The draining of the ground by the large centrifugal pump placed in a shaft on the Miami Lead & Zinc Co.'s lease on the Emma Gordon land gradually lowered the water level in the southern mines to 230 feet, and shafts were sunk to this level. The ore hoisted from the mines in the northeastern and northwestern parts of the camp came from the average depth of 225 feet. The sphalerite concentrates recovered by mills operated in the north end of the camp contained about the same average zinc content as those derived from the upper run of ore in the south end of the camp. The blende concentrates from the newly opened lower run at the south are of much better grade than those obtained from the upper ore run, which averaged about 50 per cent zinc.

The quantity of galena concentrates recovered from the ore run at depths of 200 to 240 feet in the northerly mines was much greater than that obtained from working the lower run of ore in the mines in the south end. Approximately 1 ton of galena concentrates to 2 tons of sphalerite concentrates was obtained from ore milled on the Church & Mabon leases as compared with 1 ton of galena to 5 tons of sphalerite from ore hoisted from the lower run at 217 feet at the New State mine.

At one period in the fall of the year 6 drilling machines were working northeast of the Chapman & Lennan Mining Co. and 7 south of the Frosty Mining sublease on the Miami Royalty lease. Territory south of the old Sunny Jim mine and also that south and west of the producing area were prospected. The producing mines in the district in 1912 were confined to those on leases of the Miami Royalty Co. and the Emma Gordon Mining Co. The mines on Emma Gordon land produced 55 per cent of the galena concentrates and mines on Miami Royalty land yielded 61.5 per cent of the sphalerite concentrates.

In the south end of the district a new 250-ton mill was completed in November by the Mispah Mining Co. on the old Kenwood and Index leases. This mill was not operated during 1912.

A large output of both lead and zinc concentrates was produced from the King Jack mine. A tailing mill was also operated on this lease by Zilar Bros. The High Five Mining Co. prospected the lower run of ore on the Old Chief Mine, sunk the shaft to the 235-foot level, and produced some concentrates during the latter part of 1912 from ore treated at a 150-ton concentrating plant. The Kansas Mining Co. raised ore from the 217-foot level of the New State mine during part of the year. There were 2 mills on this lease, and the production, though large, was not as much as in 1911, on account of the development work done. The Turkey Fat Mining Co. made a larger output of both lead and zinc concentrates than in 1911.

The Cactus Mining Co. constructed a new 250-ton concentrating plant at the old Swastika and Banner mines (Miami Royalty land) at the extreme southeast of the proved area. No production of concentrates was made in 1912.

The Standifer Mining Co. worked 2 shafts at the original Emma Gordon mine. Ore was hoisted from both the upper and the lower runs and was treated on the 200-ton concentrating plant.

The only output from Miami Royalty Co. land in the northern portion of the district was that of the Chapman & Lennan Mining Co. This company operated 2 shafts on Miami Royalty Co. land and milled the ore in a 250-ton concentrating plant. The crude ore or "dirt" yielded slightly more than 2 tons of sphalerite to 1 ton of galena. The large pump which has so successfully lowered the water level of the district is situated at a shaft across the road (on Emma Gordon land) southwest of the south shaft on the Miami Royalty lease. The Miami Lead & Zinc Co. had no output in 1912, but sunk another shaft and built a 250-ton mill, which was ready to operate early in 1913.

The Prairie Mining Co. sunk a shaft to the 230-foot level on a lease southwest of the Miami Lead & Zinc Co. The concentrating plant was not completed in 1912.

The larger part of the production in the northern part of the field was shipped from the Church & Mabon properties, operated by the Thirty Acre Mining Co. and the Oklahoma Lead & Zinc Co. (including the Carson-Dodson Mining Co.). The latter company has 70 acres well developed and a mill of 100 tons capacity. Another mill of 200 tons capacity was under construction. The Thirty Acre Mining Co. lease, which is directly north of the Oklahoma Lead & Zinc Co., has 1 shaft down to ore, and is equipped with a 200-ton plant. The mills operated in 1912 treated ore hoisted from the same run at a depth averaging 225 feet. The ore body has a strike N. 30° W. and is reported to be 50 to 150 feet wide, and to carry an average face of 30 feet. Long drifts were being driven for ventilation, and all the shafts (8) on the Church & Mabon lease will be connected.

The Grey Top Mining Co. was building a mill on a lease just north of the Northwest 40 of the Emma Gordon tract.

The following mines on the south part of the Miami Royalty Co. lease were producers in 1912: The Golden Hen, Willow Branch, Index, Miami Amalgamated (Sullivan lease), and Queen City-Joplin (Buckeye).

ARBUCKLE MOUNTAIN REGION.

In the southern part of Oklahoma prospecting for lead and zinc has been prosecuted in the neighborhood of Ravia, at the southeast end of the Arbuckle Mountains, and in Murray County, 8 miles southwest of Davis, near the northwest end of the same range, the last-mentioned locality having become productive in 1909. The Arbuckle Mountains consist of a core of pre-Cambrian granites and diabases overlain by the Reagan sandstone, a basal conglomerate formation of Upper Cambrian age, and that in turn by the Arbuckle limestone, of Cambrian and Ordovician age, followed by the other formations exhibited by the Paleozoic in that province. The whole uplift is greatly faulted and, especially in the mining district southwest of Davis, is sharply folded. The ore deposits in the Davis area are found in the dolomitic, Arbuckle limestone, generally in clay-filled solution channels.

One 35-ton mill operated by the United Mining & Milling Co. on the Sober-Hope land, was the only producing property in 1912. No shafts were operated, the ore being taken from the surface and an open cut 25 feet in depth. The concentrates produced were a mixture of about 80 per cent sphalerite and 20 per cent zinc carbonate. The mill was of too small capacity and unsuited for the ore, so the owners closed the mine pending the erection of a 200-ton plant.

Some development work was done by S. H. Ballard near Ravia, but the only shipments were crude ore for testing.

The following description of the region is taken from an article by L. C. Snider, assistant director of the Oklahoma Geological Survey, entitled "The Davis, Oklahoma, zinc field," published in the Mining and Scientific Press, September 2, 1911:

> In the heart of the Arbuckle Mountains, 7 miles southwest of Davis, Okla., is a zinc field which has recently shown promise of development. The productive horizon is a dolomitic member in the lower part of the Arbuckle limestone. The dolomitic outcrops from northwest to southeast along the northeast side of two large granite porphyry hills, known as East and West Timbered Hills. The belt has a length of 15 miles and an average width of less than one-half mile. The porphyry and dolomite are separated by the Reagan sandstone, of Middle Cambrian age, and the lowest portion of the Arbuckle limestone, which is a dense, thin-bedded blue-gray limestone. The limestone above the dolomite is similar to that below, except that the layers are much thicker. Locally, at least, there is an intraformational limestone conglomerate at the top of the dolomite. The limestones and dolomite dip steeply to the northeast away from the granite porphyry. The average dip is between 40° and 50°, but there is much variation due to minor folding and to faulting. Many small faults almost perpendicular to the strike cross the outcrop of the dolomite. The lateral displacement due to these faults varies from a few feet to 20 rods. In every case the northernmost block is displaced to the east. All the rocks are much broken by jointing, but this is especially true of the dolomite. A sharp blow of the hammer breaks a large block into small angular fragments, few of which are over 1 inch in any dimension. The concentration of the zinc in the dolomite is probably due to this broken condition, the small seams forming channels for the passage of circulating waters carrying zinc in solution and at the same time affording small cavities for the deposition of the ore.
>
> It is claimed by the prospectors and others interested that all the dolomite area contains rich ore, but from the present development this is only proved in a limited portion of the belt lying in secs. 17, 18, and 21, in T. 1 S., R. 1 E. Here the zinc ore occurs as the carbonate from the surface to a depth of 5 to 8 feet. Below this level the zinc is in the form of sulphide or zinc blende. The carbonate contains large proportions of dolomite. The blende is usually finely disseminated, but in some cases seems to have largely replaced the country rock, so that the blende makes up the larger portion of some of the strata. The two most important mines that have been opened show two layers of the blende-bearing rock, each 3 to 4 feet thick, separated by a layer of "dead rock" 5 to 6 feet thick, carrying only thin seams of blende. A

well being drilled on one of the properties is said to have shown the rich ore to a depth of 30 feet and to have penetrated a similar body at 125 feet below the furface. * * * The concentrate from the only mill which has been built shows 45.96 per cent. The mill was not run long enough to get the crushing machinery and tables properly adjusted, so that the showing of the concentrate is probably not so good as can be obtained. Much higher values than those shown by these analyses are reported by others, and for that reason it is judged best not to give the exact location of the samples until a larger number can be collected and analyzed.

Pyrite and marcasite are practically absent from the zinc blende in the body of ore near the surface. The cuttings from the deep body found in the well previously mentioned show some pyrite, but it is apparently in small quantity. Lead occurs in small quantity near the surface as the sulphide and as the carbonate. Copper stains are often present, and some pieces of malachite and azurite have been discovered in different parts of the field. So far no large body of copper ore is known to have been found, although there are rumors to the effect that such bodies exist.

The principal development so far consists in small openings or prospects. One company has a mill with four concentrating tables. The mill was run less than one day before the water supply was exhausted, consequently little can be said of the milling properties of the ore except that fine grinding is necessary to insure complete separation. A well is being drilled at this mill in the hope of securing a permanent water supply. Three other companies have boilers on the ground and mills ordered. One of these companies has a core-drill outfit ordered and plans to prospect thoroughly for deep-seated ore. Several carloads of carbonate ore have been shipped from the field. This is reported to have paid fairly well. One or two carloads of sulphide ore has been shipped, but the results could not be learned.

WISCONSIN.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Wisconsin in 1912 is shown in the following table:

Production of lead and zinc in Wisconsin in 1912, by districts, in short tons.[a]

District.	Ore.						Metal content.			
	Lead concentrates.		Zinc concentrates.							
	Galena.		Sphalerite.		Carbonate.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Benton	1,079	$57,003	35,017	$1,065,631	229	$4,488	797	$71,730	11,311	$1,560,918
Cuba City	743	40,005	4,683	85,042	.....	.....	594	53,460	1,026	141,588
Dodgeville	105	6,840	608	22,536	33	700	83	7,470	259	35,742
Hazel Green	299	16,476	19,617	491,988	.....	.....	217	19,530	5,703	787,014
Highland	160	8,707	157	4,446	4,108	67,612	122	10,980	1,033	142,554
Linden	163	8,381	7,664	164,912	.....	.....	124	11,160	1,908	263,304
Livingston	68	3,685	9,624	224,904	.....	.....	50	4,500	2,438	336,582
Mifflin	91	4,845	8,413	253,005	.....	.....	71	6,390	2,833	390,954
Mineral Point	.....	.....	258	4,729	.....	.....	.....	.....	58	8,004
Montfort	129	6,986	1,155	46,650	.....	.....	98	8,820	393	54,234
Platteville	162	8,529	13,835	507,137	.....	.....	123	11,070	5,579	769,902
Shullsburg	374	19,204	1,586	37,912	.....	.....	302	27,180	508	70,104
State total	3,373	180,661	102,617	2,908,892	4,370	72,800	2,581	232,290	33,050	4,560,900
1911	4,359	229,465	93,963	1,929,123	5,035	74,143	3,353	301,770	29,720	3,388,080
1910	5,608	286,493	89,232	1,750,574	5,269	69,588	4,413	388,344	25,927	2,800,116
1909	4,659	254,514	65,421	1,505,752	5,130	63,603	3,694	317,684	23,152	2,500,416

[a] In calculating the metal content of the ores from assays allowance has been made for smelting and concentration losses in case of zinc, but not in case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer and that the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1911 and 1912.

	1911	1912
Total crude ore.....short tons..	1,123,040	1,363,636
Total concentrates in crude ore:		
Lead.....per cent..	0.4	0.25
Zinc.....do....	8.8	7.6
Metal content in crude ore:		
Lead.....do....	.3	.2
Zinc.....do....	3.1	2.9
Average lead content of galena concentrates.....do....	76.9	76.5
Average zinc content of sphalerite concentrates.....do....	34.6	38.4
Average zinc content of zinc carbonate concentrates.....do....	33.1	29.6
Average value per ton:		
Galena concentrates	$52.41	$53.57
Sphalerite concentrates	20.53	28.34
Zinc carbonate concentrates	14.72	16.66

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and comprise the most important part of the ore deposits of the upper Mississippi Valley region. The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite or zinc blende, and smithsonite or zinc carbonate, the latter locally known as "dry bone." As a lead region the district has been known from the earliest settlement days. In time the building of smelters near by made a market for the zinc ores. The first zinc ore to be mined was the carbonate found in association with lead in the shallow working above ground-water level. When all the main deposits were worked out down to water level there was a lull in mining in the region. Though the carbonate was known to give place to zinc blende and the lead to continue on below water, it was not deemed profitable to mine when continued pumping was necessary. About 8 or 10 years ago the higher price of zinc led to the opening of some of the deposits below water level, since which time zinc mining has increased until Wisconsin in 1911 and 1912 stood third in rank among zinc-producing States. The ore bodies are found in perpendicular, horizontal, or inclined cavities known as "openings" or "crevices," "flats," and "pitches." These openings sometimes extend for considerable distance in a straight line called a "range," and may be operated at different places by different companies. When a range is once established it becomes an important guide in prospecting.

The galena of the district is nonargentiferous, and so far as known the zinc ores are free from cadmium. In some of the mines marcasite is so plentiful that the zinc blende concentrates are reduced to a very low grade. Owing to their nearness in specific gravity, marcasite and blende are very difficult to separate cleanly by hydraulic methods. Both electrostatic and electromagnetic separation processes have been used.

A small number of the concentrating plants in the district are equipped with roasters and magnetic separators. Some mining companies having such equipment did not operate it, and many of the companies constructing milling plants in 1912 did not report the erection of roasters. It is believed by many mine owners that it is more economical to sell the green concentrates than to invest in a roasting plant, entailing the employment of extra shifts of men during the entire day of 24 hours.

The Galena (Ill.) plant of the Joplin Separating Co., which makes a business of separating low-grade blende-marcasite ores, destroyed by fire in the latter part of 1911, was reconstructed on a larger scale. The Mineral Point Zinc Co. operates a roaster and magnetic separator at Mineral Point, Wis., and green concentrates were treated by the Wisconsin Separating Co. at Benton, the National Zinc Separating Co. at Hazel Green, the Empire roaster at Platteville, and the Campbell Magnetic Separating Co. at Cuba City. The last-named company uses a patented process, which requires the ore to be only slightly roasted and which recovers the marcasite and pyrite in shape for sale to acid manufacturers.

At the other five plants the concentrates, after being dried, are roasted, the customary form of roaster being a long, slowly revolving cylinder lined with fire brick. The roasting is carried far enough to render the marcasite magnetic, but not to drive off all the sulphur, after which the concentrates are passed under a magnetic separator, which removes the iron.

The plant of the American Zinc Ore Separating Co., of Platteville (which was equipped with driers and both Blake-Morscher and Huff electrostatic separating machines), was destroyed by fire in 1911 and was not rebuilt.

The multiplication of individual and custom roasters, by raising the low-grade ore to high grade, will have a tendency to reduce relatively the tonnage of zinc concentrates, though, of course, the metal content and the value will be less affected; hence these last must serve as the basis of comparison for different years.

About 50 per cent of the sphalerite concentrates shipped in 1912 went to the separating companies. The quantity of roasted concentrates sold by the mining companies was small when compared with the aggregate shipments. The only roaster and separating plant installed in 1912 by mining companies was that of the Linden Zinc Co., at Linden. The average zinc content of the sphalerite concentrates sold in 1910 was 34.8 per cent and the average price per ton was $19.62; the corresponding content and price for 1911 were 34.6 per cent and $20.53, and in 1912 the corresponding content and price were 38.4 per cent and $28.34.

Milling practice is much as in the Joplin region, except that in Wisconsin everything is on a smaller scale. Mills of 100 tons or over, with rougher, cleaner, sand jigs, and concentrating tables, have generally been built in the last few years. There were about 50 new concentrating plants erected in 1907, many of them being of the larger size. Mill construction was naturally much less active in the following years.

The mills built in 1912 with their reported capacity (per 10-hour shift) and location were the following: Field Mining & Milling Co., 130 tons, at Benton; Raisbeck mine of Vinegar Hill Zinc Co., 100 tons; Universal Mining Co., 150 tons, at Cuba City; Wisconsin Zinc Co. (at Badger mine), 50 tons, at Hazel Green; Glanville Mining Co., 50 tons; Optimo Mining Co., 100 tons, at Linden; Shamrock Mining Co., 50 tons, at Mifflin; Mound City Mining Co., 100 tons; East Side Mining Co., 100 tons, at Platteville.

The crude ore yields from 5 to more than 20 per cent of zinc concentrates, and the building contracts in the case of the larger mills

generally call for a saving of 85 per cent of the blende in the crude ore, but very likely in practice this figure is not nearly attained. The mining methods are largely determined by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin.

The zinc carbonate ore, which is mined principally in the Highland district, is chiefly purchased by the Mineral Point Zinc Co. and made into zinc oxide in the plant at Mineral Point, Wis. A considerable quantity of the low-grade zinc blende concentrate is used in the same way.

The value of the mine output of lead and zinc in the year 1912 was $4,793,190, against $3,689,850 in 1911, so that the increase was $1,103,340. The average metal content of the galena concentrates was slightly lower than in 1911 and that of the sphalerite concentrates was 3.8 per cent higher.

The quantity of sphalerite concentrates sold increased from 93,963 tons in 1911 to 102,617 tons in 1912, and the value increased from $1,929,123 in 1911 to $2,908,892 in 1912.

The galena shipments declined from 4,359 tons, valued at $229,465, in 1911, to 3,373 tons, valued at $180,661, in 1912, and the metal content in 1912 was 772 tons less than in 1911. The Benton district produced the largest quantity of galena. Cuba City was the next largest producer, and Shullsburg (where the "dirt" milled yielded about 1 ton of galena to 4 tons of sphalerite) was the third largest producer. These three districts shipped about 65 per cent of the galena concentrates sold in Wisconsin in 1912. The output of zinc carbonate concentrates was 665 tons less than in 1911, but the value, owing to an increase in price of $1.96 a ton, was only $1,343 less than in 1911.

The mines of the Highland district contributed 94 per cent of the production of zinc carbonate as compared with 95 per cent in 1911.

The quantity of crude ore treated by concentrating plants increased from 1,123,040 tons in 1911 to 1,363,636 tons in 1912, but the concentrates in crude ore declined from 9.2 per cent to 7.85 per cent, and the metal content of these concentrates declined from 3.4 per cent to 3.1 per cent.

The increase of about 10 per cent in the quantity of ore mined and milled and the decrease of 1.35 per cent in the average quantity of concentrates recovered from crude ore showed distinctly that the very largely increased price paid for zinc concentrates had the effect of causing more extensive operations on thinner and lower-grade ore bodies. The high price paid for zinc concentrates probably had a tendency to reduce the output of galena, which is often, in large part, derived from shallow workings by small operators, who prospect more actively when zinc prices are low and the demand for mining labor slack.

The metal content of the sphalerite sold by the mines varied from 15 per cent to 58.9 per cent. The larger portion of the concentrates sold ranged between 28 and 40 per cent, but the average zinc content has increased considerably during the last two years. This increase was not wholly due to the roasting plants operated by mine owners, but was partly due to the shipment of a very large output of high-grade green concentrates by the Field Mining & Milling Co. at Ben-

ton. The advance in the output of sphalerite in Wisconsin is best shown by the fact that the output has increased from 65,421 tons, valued at $1,505,752, in 1909, to 102,617 tons, valued at $2,908,892, in 1912. The 1912 production would probably have been considerably larger if mine operators had not been handicapped by scarcity of mining labor. The ordinary muckers and helpers are a larger per cent of floating workers and are less efficient than those employed in the Missouri districts.

Although drilling was active in many of the camps and resulted in a great amount of development, the area of proved mining territory was not expanded materially. No distinctly new mining camps were established, and the new ore bodies located were in close proximity to ranges already proved. The larger mining interests, including the Mineral Point Zinc Co., Wisconsin Zinc Co., and Vinegar Hill Zinc Co., continued to add to their holdings by lease or purchase. In addition the Cleveland Mining Co., the Frontier Mining Co., and the Optimo Mining Co. increased the scope of their operations by acquiring new fees or leases. The new development work and property transfers are set forth under the district reviews.

REVIEW BY DISTRICTS.

Benton district.—This district produced about 32 per cent of the galena concentrates and 34 per cent of the sphalerite concentrates sold in Wisconsin in 1912. The production increased about 8 per cent and was very much larger than that of any other Wisconsin district. The increase was mainly due to the large output of galena and blende concentrates shipped by the Field Mining & Milling Co. The total value of all concentrates shipped increased from $602,311 in 1911 to $1,127,122 in 1912.

The Wisconsin Zinc Co. operated the Winskill mine, which had a production of concentrates larger in quantity (but not in value) than that of any other mine in the district. The 2 shafts are 125 feet and 115 feet deep, respectively, and the property is equipped with a 100-ton mill, driven by electric power. The Drum mine, which has a shaft 120 feet deep, was idle in 1912.

The Fox mine, owned by the Mineral Point Zinc Co., was a large shipper of sphalerite, and the mine workings were further developed and drifts run from the Fox to the Weigle land. The shaft at the mine is 100 feet deep, and the electrically operated concentrating plant has a capacity of 100 tons.

The Vinegar Hill Zinc Co. operated the Wilkinson and the Rowley mines and made a considerable production. The Wilkinson mine has a shaft down 90 feet and an electrically-driven concentrating plant of 100-ton capacity. The Rowley mine on the Gillette land is equipped with a 75-ton plant, which was also operated by electric power. In addition to the output of galena and blende concentrates a large quantity of marcasite averaging 43.57 per cent of sulphur was shipped from the Wilkinson mine. The blende concentrates derived from the ore from the Wilkinson mine have a much lower zinc content than those from the ore of the Rowley mine.

The Lucky Twelve Mining Co., located on the Murphy land, was one of the large producers. The shaft at this mine is 125 feet deep, and the mill has a capacity of 200 tons per 12 hours. This mine is

equipped with a roasting plant and about 50 per cent of the blende concentrates sold averaged 55 per cent zinc content.

The Ewing Mining Co. operated the Etna mine by means of an 82-foot shaft and recovered some concentrates from ore treated at the 150-ton mill.

The Field Mining Co. had the largest output of high-grade green sphalecrite concentrates in Wisconsin in 1912, in addition to a good production of galena concentrates. The sphalerite sold in 1912 had an average zinc content of 56.4 per cent. This mine is situated on the Crawhall land. The ore is hoisted from the depths of 160 to 210 feet by means of 2 shafts, and treated on a 130-ton concentrating plant.

Two leases on the Hird and the Sedgwick lands were under development by the Frontier Mining Co., and the usual large production was made. Two shafts and one 75-ton concentrating plant were operated.

The New Eureka Mining Co., on the Champion Mining Co.'s land, extracted ore from depths ranging between 125 and 150 feet, by means of a tunnel, and operated a small mill which turned out a fair output of concentrates. Improvements were made both underground and in the mill.

The old Jack of Clubs mine was taken over by the Lafayette Mines Co. late in 1912, and new ore bodies were located and opened up.

The Schrier Steffen Co. started work on the Sally Waters mine, and the mill will be operated early in 1913.

Longhenry Bros. sunk 4 shafts on the Spenceley land. These shafts were 24, 100, 90, and 144 feet deep. Some ore was extracted during development, but none was treated. The owners intend to cut several drifts before erecting a concentrating plant.

The Kearns mine was leased by the Grand View Mines Co. and equipped with a crusher and hand jigs, by means of which a good output of zinc carbonate concentrates was made.

Other producing mines in 1912 were F. Horsley & Co., Keenan Bros., McCabe Mining Co., and the Garden City Mining Co.

Cuba City–Elmo district.—The production of lead concentrates in 1912 in this district was 142 tons more than in 1911 and that of sphalerite was 1,498 tons more than in 1911. Most of the 1912 output came from new properties or old mines operated by new companies. Several mines formerly very productive were closed down throughout the year.

The Jarrett mine on the Banfield land, under lease to the M. & D. Mining Co., was the largest producer of both lead and zinc concentrates in the district. The value of the production of lead concentrates exceeded the value of the zinc concentrates sold. The new pumps were successful in controlling the water. The ore hoisted and milled in the 100-ton concentrating plant averaged about 10 per cent in galena and sphalerite in about the proportion of 1 of galena to 2 of sphalerite.

The Baxter mine was purchased and the mill operated after the first of October by the Burr Mining Co. The shipments of concentrates were considerable.

The Peaceful Valley Mining Co., a large producer in former years, was unfortunate in having its concentrating plant and other equip-

ment burned during February. The property was thoroughly drilled pending the erection of new equipment.

A new 100-ton mill was erected on the Raisbeck land by the Vinegar Hill Zinc Co., and a large output of low-grade sphalerite was produced during the latter part of 1912.

The Universal Mining Co. erected and operated a 150-ton concentrating plant at the Lawrence mine. The mill was completed in June and ore from a shaft 87 feet deep was treated during the remainder of the year.

A small output of concentrates was shipped by the Wisconsin Zinc Co., which was recovered from ore mined at the Wicklow mine and treated at the Jarrett mill. The shaft at the Wicklow mine is 90 feet deep.

R. A. Fox operated a lease on the Vandeventer, which is equipped with a 50-ton concentrating plant and a roasting and separating plant of 20 tons capacity.

The Barnett Development Co. took over the old Roosevelt lease on the Badger land and conducted an active search for new ore bodies. A new range was located by drilling and a shaft was started.

The Campbell Magnetic Separating Co. and the National Zinc Separating Co. (Vinegar Hill Zinc Co.) purchased green blende concentrates in 1912 and in addition to shipping the roasted blende they sold about 2,500 tons of marcasite or iron sulphide.

No output of concentrates was reported by mines near Elmo and the only development was that by the Beloit Merger Mining Co. This company was sinking a new shaft and installed new oil engines and an air compressor.

Dodgeville district.—The production of lead concentrates increased in this district from 70 tons in 1911 to 105 tons in 1912, and the output of sphalerite from 263 tons in 1911 to 608 tons in 1912. The Lucky Five Mining Co., on the Davis land, was the largest producer of zinc concentrates. The shaft at this mine is 100 feet deep, and the concentrator has a capacity of 50 tons. The Treweek land was leased by the Lucky Five and drilled, a shaft was sunk, and other development work was done. Harney, Bengeley & Davey shipped galena and sphalerite concentrates from a mine on the Hughes land.

Carroll Guthrie operating on the Thompson land, mined some ore at a depth of 75 feet, which he milled on a 20-ton mill.

The only other producers of concentrates in 1912 were Evans Bros. and Owens & Williams.

Hazel Green district.—Although there were only four producing properties in this district in 1912 the production of lead concentrates amounted to 299 tons and sphalerite concentrates to 19,617 tons. The district ranked second in point of production in Wisconsin in both 1911 and 1912, although the quantity of both lead and zinc concentrates shipped in 1912 was slightly less than in 1911. The increased output of the Cleveland mine and of the Federal mine compensated for the smaller production made by the Kennedy and the Mills mines when compared with the yield in 1911.

The Kennedy mine of the Mineral Point Zinc Co. is the largest in the district, and was also one of the largest producers of sphalerite concentrates in Wisconsin in 1912. Only one concentrating plant of 125 tons was operated in 1912, and the output was much less than in 1911, when two mills were in operation.

The Cleveland Mining Co., leasing on the Wetherbee land, almost doubled the 1911 output of high-grade lead and zinc concentrates. The ore was hoisted by a 140-foot shaft and milled on a 150-ton electrically driven concentrating plant. The Federal Lead-Zinc Co., operating on the Gray land, shipped a large quantity of low-grade sphalerite concentrates to the separating companies. The mine is equipped with a 150-foot incline shaft and a 75-ton mill.

The Mills mine of the Wisconsin Zinc Mining Co. continued to make a large production. Two shafts were operated at this mine, and electric power is used at the mill, which has a capacity of 200 tons daily. The roaster and separator has a daily capacity of 50 tons. A new mill was under construction at the Badger mine, from which no ore was hoisted in 1912.

Highland district.—The production of zinc concentrates in this district was considerably less than in the preceding year. There was, however, more development work accomplished during 1912 in the district, which is the most northerly one in the upper Mississippi Valley region. The output of galena concentrates declined from 206 tons in 1911 to 160 tons in 1912. The production of sphalerite concentrates was small in 1912, but it was almost double that sold in 1911.

The production of zinc carbonate concentrate, which constitutes the bulk of production from the district, declined from 4,784 tons in 1911 to 4,108 tons in 1912. About 50 per cent of the galena and 73 per cent of the zinc carbonate was produced by the Highland and Franklin mines. It is reported that the Mineral Point Zinc Co., which owned a half interest in these two properties, bought the other half interest. The Mineral Point Zinc Co. also purchased the mine and equipment formerly operated by the Madison Mines & Development Co., on the Centerville Mining Co.'s land. The Clark and the Minter mines and concentrating plants were idle the entire year. The only concentrating plants in operation in 1912 were those at the Highland and the Franklin mines.

The output of the smaller producers is prepared for the market by means of hand jigs or washing plants.

The Burrichter mine was worked by Delaney & Miller, who sold some galena and zinc carbonate. Lampe & Steppler obtained some rich ore by means of a 45-foot shaft and made the only large shipment of high-grade sphalerite concentrate. Kennedy & Egan opened a new mine on the Muldoon land and shipped some sphalerite concentrate derived from ore mined at the 67-foot level. Other shippers of sphalerite, galena, or zinc carbonate in 1912 were the Frank Kroll Mining Co., H. Topp & Co. (Gilliam diggings), Madison Mining & Development Co., Hying Mining Co., John Kreul, North Pole Mining Co. (Webbking lease), Schaack Mining Co., and Whelan Bros.

The Fecht Mining Co. and the Atlas Mining Co. were mining zinc carbonate ore from a depth of about 50 feet, but no concentrates were sold by them in 1912.

Linden district.—The production of sphalerite concentrates in the Linden district was 653 tons less than it was in 1911, but the value of all the concentrates sold was $38,520 greater than in 1911. The Optimo Mining Co. was again the largest producer. The ore was mined from the 106-foot level by means of one shaft and was concen-

trated in a 50-ton mill. This company obtained a lease on the Smith-Hancock land, developed the land, and constructed a new 100-ton electrically operated concentrating plant. This new mill, which is supplied with power by the Mineral Point Public Service Co., was not operated in 1912. An electrostatic roasting and separating plant was also under construction by interests affiliated with the Optimo Mining Co. This plant, which will also be supplied with electric power, will be utilized to treat green sphalerite concentrates from both of the mines of the Optimo and also those purchased from other producers.

Ross Bros. sold the largest quantity of galena concentrate and the second largest quantity of sphalerite concentrate in 1912. The shaft at this mine is 120 feet deep and the concentrating plant has a capacity of 60 tons. The Hinkle Mining Co. was another large producer of both galena and sphalerite. One 80-foot shaft was used to hoist ore for the 50-ton mill. A new 50-ton mill was built by the Glanville Mining Co. on the W. M. Smith land and operated on ore hoisted from an 85-foot shaft. The Rajah mine, owned by the Mineral Point Zinc Co., which has a 100-foot shaft and a 50-ton mill, was operated until September.

Livingston district.—Owing to the greater activity at the Coker and Ellsworth mines, the production of blende concentrates in this district increased from 7,987 tons in 1911 to 9,624 tons in 1912.

The Coker mine of the Mineral Point Zinc Co. was again the largest producer of both galena and sphalerite. The 100-ton mill was operated double shift most of the year. The Sunrise mine was acquired by the Mineral Point Zinc Co. and was being equipped for future operation.

The Vinegar Hill Zinc Co., operating the Ellsworth mine, shipped a large quantity of sphalerite to the National Zinc Separating Co. at Benton. The concentrating plant at this mine has a capacity of 100 tons.

The mill of the Lost Mining Co. was not operated in 1912 (though a small output of concentrates was obtained by lessees from surface working), the company confining its work to drilling 17 holes and sinking an 80-foot shaft.

The Senator and Sunset mines were idle all year. The Senator property is reported to have been sold to Brown & O'Kell.

Mifflin district.—The output of Mifflin district in 1912 was 91 tons of galena concentrate, valued at $4,845, and 8,413 tons of sphalerite concentrate, valued at $253,005. The shipments of galena in 1912 were 386 tons less than in 1911, but those of sphalerite increased 693 tons. None of the mines are equipped with roasters, so that the sphalerite shipments consisted entirely of "green" concentrate.

The Squirrel mine of the B. M. & B. Mining Co. produced most of the galena concentrate and a large tonnage of the high-grade sphalerite concentrate of the district. The shaft at this mine is 75 feet deep, and the concentrating plant has a capacity of 50 tons per shift.

The Peacock mine, on the Jenkin land, operated a 25-ton mill and made a considerable yield of concentrate. Three shafts of about 110 feet deep were in use during the year. The Grunow mine, on the Miller land, was operated by means of a 100-foot shaft, and the ore was milled at a 50-ton concentrating plant.

The Peni mine was operated by means of a tunnel connected with a number of old shafts. The concentrating plant has a capacity of 75 tons.

The Lucky Six Mining Co. operated the Dodger mine by means of a 50-foot shaft and had a much increased output in 1912. The motive power at the 150-ton mill was changed from gasoline to electric. A large portion of the waste rock broken was not hoisted to the surface, but was piled up in the workings to support the roof.

The production from the Slack mine was less than in 1912, and the mill was shut down in the fall of the year on account of the exhaustion of the ore body.

The Shamrock Mining Co. sunk three shafts on the Ross Bros. land and erected an electrically equipped concentrating plant of 50 tons.

A very fair output of sphalerite was shipped from the Clayton Mining Co.'s lease on the Cushman & Nolan land. The ore was hoisted through a 110-foot shaft and concentrated by means of hand jigs.

A shaft was sunk by the Biddick Mining Co., but the property did not reach the producing stage in 1912.

Mineral Point district.—The production of this district in 1912 was small, being only about one-third that of 1911. The Liverpool, Harris, and Holman mines made no output. The Merry Christmas mine, which was purchased by the Mineral Point Zinc Co. late in 1911, and which is equipped with a 50-ton mill using electric power, was operated for about four months, but only a small portion of the concentrates produced was shipped. A new shaft was sunk by the Tripoli Mining Co., after prospecting had disclosed new ore bodies. Only a small production was made in 1912.

The Mineral Point Zinc Co. added a new modern power plant and other improvements to the oxide works at Mineral Point.

The Mineral Point Public Service Co. was organized for the purpose of supplying light and power to the surrounding districts. The main transmission line was completed to Linden, Livingston, and Mifflin and will be extended to Montfort, Highland, and other camps.

Montfort district.—The shipments of sphalerite concentrates in 1912 were slightly less than in 1911. The O. P. David Mining Co. was again the largest producer. The ore, which is of good grade, was hoisted by means of 2 shafts, each 127 feet deep, and concentrated at a 60-ton mill. The Relief mine owned by the Madison Mining & Development Co., and the properties of the Nagle Mining Co. and of the United Mining Construction & Manufacturing Co., were idle all year.

Platteville district.—The mine production of sphalerite in this district in 1912 was 1,087 tons more than in 1911, and the district produced a larger proportion of roasted concentrates than were shipped from other Wisconsin districts.

The Wisconsin Zinc Co. operated the Empire, Grant County, and East End mines during the year, and also the Empire roasting plant. The largest output was derived from the Empire mine, which is equipped with a 100-ton concentrating plant.

The Grant County mine, which is equipped with a 140-foot shaft and a 75-ton concentrating plant, was operated not only by the Wis-

consin Zinc Co., but also by the Vinegar Hill Zinc Co. and the Young Exploration Co. Apparently none of the operations were attended with much success.

The Homestead mine on the Shepherd estate was a large producer of sphalerite concentrates, which were roasted before being sold. The Homestead mill has a capacity of 150 tons.

The Klar Piquette Mining Co. was one of the largest producers of 50 per cent sphalerite concentrates in Wisconsin in 1912. Two 100-foot shafts were used to hoist ore which was milled at a 100-ton concentrating plant. This company also drilled several other leases, which gave indications of good ore bodies. A new shaft was being sunk on the David Weigel land adjoining the original lease now operated.

The East End mine, after being brought to the productive stage, was purchased by the Wisconsin Zinc Co. This mine was the most successful one developed in 1912, and a large output of sphalerite was shipped. The shaft at the East End mine is 110 feet deep, and the lease is equipped with a 100-ton concentrating plant, erected in 1912.

The old Platteville Lead & Zinc Co.'s mine and 50-ton mill were operated by the New Enterprise Mining Co. and made a fair yield of concentrates.

The old Trego mine and 50-ton mill were operated for a short time and some low-grade concentrates were shipped. The property is now leased to the Wisconsin Separating Co.

The mill at the Hodge mine of the Mound City Mining Co., which was burned in 1911, was rebuilt, but the water was not pumped out of the mine in 1912.

The St. Rose, Columbia, Cruson, Stark, Broadway, and Highland Park mines were not productive in 1912.

Shullsburg district.—The shipments of galena concentrates decreased 244 tons in 1912, but the sphalerite shipments increased 1,260 tons, compared with the figures for 1911. The Rodham Mining Co., which is one of the largest producers of galena in Wisconsin, shipped most of the galena concentrates and a larger quantity of sphalerite concentrates than any other mine. Ore was hoisted through one shaft from the 95-foot level and concentrated at a mill having a capacity of 25 tons. A new pump shaft was sunk, and addition made to the surface plant. The Brown-Croft mine of the Iron River Leasing Co. was taken over by the Vinegar Hill Zinc Co. The mine was fully developed, and the 100-ton milling plant renovated. After the improvements were finished a good production of both galena and sphalerite was made. The Milwaukee-Shullsburg Mining Co. operated a 126-foot shaft and a 50-ton mill. During prospect drilling several new ore bodies were located.

The Farrey Gratkin Mining Co. on the Kearns land hoisted ore by means of two shafts from ore bodies between 50 and 80 feet. The concentrates were recovered by crushing and hand jigging. Only development work was done by Metcalf Bros., and the Climax mine, belonging to E. D. Maloy, was a small producer of galena.

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[1] The publications for which a price is given are no longer available for free distribution, but can be purchased from the Superintendent of Documents, Washington D. C.; others can be obtained free on application to the Director of the United States Geological Survey. Some are out of print but may be examined in libraries.

PRECIOUS AND SEMIPRECIOUS METALS IN THE WESTERN STATES IN 1912.

(MINE PRODUCTION.)

ALASKA.

By Alfred H. Brooks.

INTRODUCTION.[1]

Metalliferous mining in Alaska made important advances during the year 1912. Although the output of the gold placers was less than in 1911, yet the installation of large plants, notably of dredges, in many districts augurs well for the future of this industry. More important was the progress made in lode gold mining, which occurred in most of the auriferous districts of the Territory. The gold output of lodes was greater than in previous years, and it is probable that it will double before many years. Copper mining also advanced, partly because several large plants increased their output, partly because a number of small mines were developed on account of the high price of copper. The development of the coal fields still awaits the establishment of a definite policy in regard to the disposition of the public coal lands. The delay in securing cheap fuel for the Territory has now for many years caused a stagnation in many industries. Railway construction and, to a certain extent, operation have stopped and many mining enterprises have been hampered, if not entirely abandoned, on account of the fuel question. Very few Alaskans have any direct interest in coal claims or in mining, but the entire population of the Territory is desirous of seeing the coal fields developed, because it is believed that this will bring about advancement in many other industries. Above all, it will encourage the operation and, to a certain extent, the construction of railways, which are all important to the Territory.

From the standpoint of increase in production over that of previous years copper mining was of first importance in 1912. Several new copper mines were opened in the Prince William Sound region, and development work was actively pushed in the Ketchikan and the Kotsina-Chitina districts. There was also a considerable increase in the output of the auriferous lodes compared with the production of the previous year. Several lode mines are being opened in the Juneau district, which will be provided with large reduction plants. Many smaller lode-mining enterprises were developed in 1912, notably in Fairbanks district, Kenai Peninsula, Port Valdez district, and in Willow Creek district. Promising lode discoveries were made at Port

[1] Aid has been rendered in the preparation of this report by E. M. Aten, who has assisted in the collection of statistics from mines. The data on mining development here presented are all taken fom Bulletin 542, which deals with the region in a more detailed way.

Wells, on Prince William Sound, while the far less amount of lode prospecting done in the Innoko-Iditarod region yielded very encouraging results.

Though the placer production at Fairbanks fell off, this continues to be the most important placer camp. The output of the Iditarod-Innoko region and of the Nome and other districts of the Seward Peninsula was about the same as in 1911. The most hopeful feature of the placer mining industry was the continuation of the installation of dredges. Some 38 dredges were operated in Alaska during 1912, and a number of others were under construction. Of these, three are in the Fortymile district, one in each of the Fairbanks, the Birch Creek, the Iditarod, and the Kenai Peninsula districts, and the rest are on Seward Peninsula.

As in previous years, attempt has been made to base statistics of production, so far as possible, on statements of individual producers—the only reliable source of information. Though the cordial cooperation of most of the important mine operators has been secured, there are still a few large producers of placer gold and many smaller ones who neglect to reply to the request for information. In connection with this work the writer is under special obligations for valuable information to the Director of the United States Mint, to the collectors of the customs service, to the many United States commissioners in the Territory, to officials of banks and of transportation companies, and to prominent residents. All these data have been carefully sifted, and the accompanying figures are based upon them. The limit of error of the statement of the total gold production of the Territory is believed to be within 2 per cent. In the crediting of the proper amounts to individual districts, however, the error may be in some cases as high as 8 per cent.

PRODUCTION.

The production of gold, silver, and copper in Alaska for 1911 and 1912 are shown in the following table:[1]

Mine production of gold, silver, and copper in Alaska, 1911–12.

Year.	Gold.		Silver.		Copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine oz.		*Fine oz.*		*Pounds.*		
1911	815,276.26	$16,853,256	460,231	$243,922	27,267,878	$3,408,485	$20,505,664
1912	829,435.38	17,145,951	515,186	316,839	29,230,491	4,823,031	22,285,821
Increase, 1912.	14,159.12	292,695	54,955	72,917	1,962,613	1,414,546	1,780,158

[1] According to C. E. Siebenthal, the smelter reports showed a return of 51 tons of lead from Alaska ores in 1911, valued at $4,590, and of 45 tons in 1912, valued at $4,050.

The following table is an estimate of the total production of gold, silver, and copper in Alaska since the beginning of auriferous mining in 1880. For the early years the figures are probably far from being correct, but they are based on the best information now available.

Production of gold, silver, and copper in Alaska, 1880–1912.

Year.	Gold.		Silver.		Copper.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.
1880	967	$20,000				
1881	1,935	40,000				
1882	7,256	150,000				
1883	14,561	301,000	10,320	$11,146	3,933	$826
1884	9,723	201,000				
1885	14,512	300,000				
1886	21,575	446,000				
1887	32,653	675,000				
1888	41,119	850,000	2,320	2,181	.....	.....
1889	43,538	900,000	8,000	7,490	.....	.....
1890	36,862	762,000	7,500	6,071	.....	.....
1891	43,538	900,000	8,000	7,920	.....	.....
1892	52,245	1,080,000	8,000	7,000	.....	.....
1893	50,213	1,038,000	8,400	6,570	.....	.....
1894	62,017	1,282,000	22,261	14,257	.....	.....
1895	112,642	2,328,500	67,200	44,222	.....	.....
1896	138,401	2,861,000	145,300	99,087	.....	.....
1897	118,011	2,439,500	116,400	70,741	.....	.....
1898	121,760	2,517,000	92,400	54,575	.....	.....
1899	270,997	5,602,000	140,100	84,276	.....	.....
1900	395,030	8,166,000	73,300	45,494	.....	.....
1901	335,369	6,932,700	47,900	28,598	250,000	$40,000
1902	400,709	8,283,400	92,000	48,590	360,000	41,400
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000
1904	443,115	9,160,000	198,700	114,934	2,043,586	275,676
1905	756,101	15,630,000	132,174	80,165	4,805,236	749,617
1906	1,066,030	22,036,794	203,500	136,345	5,871,811	1,133,260
1907	936,044	19,349,743	149,784	98,857	6,308,786	1,261,757
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267
1909	987,417	20,411,716	147,950	76,934	4,124,705	536,211
1910	780,131	16,126,749	157,850	85,239	4,241,689	538,695
1911	815,276	16,853,256	460,231	243,922	27,267,878	3,408,485
1912	829,435	17,145,951	515,186	316,839	29,230,491	4,823,031
Total	10,292,541	212,765,727	3,094,048	1,841,202	90,293,477	13,570,225

The value of the production of gold in Alaska in 1912 is estimated at $17,145,951, that of silver, $316,839, and the number of ounces of gold at 829,435 and of silver at 515,186. In 1911 the output of gold was valued at $16,853,256. The copper output of Alaska for 1912 was 29,230,491 pounds, valued at $4,823,031, an increase from 1911 of 1,962,613 pounds.

Comparison is made in the following table between the gold production of 1911 and 1912, by districts:

Value of production of gold in Alaska in 1911 and 1912, by districts.

District.	1911	1912	Increase (+), decrease (−).
Pacific coast belt, including southeastern Alaska and Prince William Sound	$4,265,573	$4,904,753	+$639,180
Copper River and Cook Inlet region	313,538	358,401	+ 44,863
Yukon and Kuskokwim basins	9,139,145	8,857,797	− 281,348
Seward Peninsula and northwestern Alaska	3,135,000	3,025,000	− 110,000
Total	16,853,256	17,145,951	+ 292,695

Value of production of gold in Alaska, with approximate distribution, 1880–1912.

Year.	Pacific coast belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula and northwestern Alaska.	Total.
1880	$20,000				$20,000
1881	40,000				40,000
1882	150,000				150,000
1883	300,000		$1,000		301,000
1884	200,000		1,000		201,000
1885	275,000		25,000		300,000
1886	416,000		30,000		446,000
1887	645,000		30,000		675,000
1888	815,000		35,000		850,000
1889	860,000		40,000		900,000
1890	712,000		50,000		762,000
1891	800,000		100,000		900,000
1892	970,000		110,000		1,080,000
1893	838,000		200,000		1,038,000
1894	882,000		400,000		1,282,000
1895	1,569,500	$50,000	709,000		2,328,500
1896	1,941,000	120,000	800,000		2,861,000
1897	1,799,500	175,000	450,000	$15,000	2,439,500
1898	1,892,000	150,000	400,000	75,000	2,517,000
1899	2,152,000	150,000	500,000	2,800,000	5,602,000
1900	2,606,000	160,000	650,000	4,750,000	8,166,000
1901	2,072,000	180,000	550,000	4,130,700	6,932,700
1902	2,546,600	375,000	800,000	4,561,800	8,283,400
1903	2,843,000	375,000	1,000,000	4,465,600	8,683,600
1904	3,195,400	500,000	1,300,000	4,164,600	9,160,000
1905	3,430,000	500,000	6,900,000	4,800,000	15,630,000
1906	3,454,794	332,000	10,750,000	7,500,000	22,036,794
1907	2,891,743	275,000	9,183,000	7,000,000	19,349,743
1908	3,448,318	401,500	10,323,000	5,120,000	19,292,818
1909	4,264,716	265,000	11,580,000	4,302,000	20,411,716
1910	4,182,730	351,630	8,062,389	3,530,000	16,126,749
1911	4,265,573	313,538	9,139,145	3,135,000	16,853,256
1912	4,904,753	358,401	8,857,797	3,025,000	17,145,951
Total	61,382,627	5,032,069	82,976,331	63,374,700	212,765,727

In 1912 about 29 per cent of the total gold production came from lode mines, compared with 25 per cent of the total gold output credited to lode mines in 1911. It is expected that a very rapid increase in the percentage of lode output will take place in a few years, when the many lode enterprises already started will reach a productive stage. The placer mining output will probably continue to decrease for several years, until more large installations of placer mining plants have been made. In the following table, the production of precious metals has been distributed as to sources.

Sources of gold, silver, and copper in Alaska, 1912, by kinds of ores.

	Tonnage.	Gold.		Silver.		Copper.	
		Ounces.	Value.	Ounces.	Value.	Pounds.	Value.
Siliceous ores	1,761,814	241,991.05	$5,002,399	35,696	$21,952		
Copper ores	93,452	7,428.08	153,552	376,593	231,605	29,230,491	$4,823,031
Placers		580,016.25	11,990,000	102,897	63,282		
Total	1,855,266	829,435.38	17,145,951	515,186	316,839	29,230,491	4,823,031

The total production of gold from the auriferous lode mines of Alaska which have been productive since 1882 is estimated to be 27,966,622 fine ounces, valued at $57,811,300. These mines have also produced

1,065,439 fine ounces of silver, with a commercial value of $648,854. Twenty-four gold lode mines, including several properties in the new lode districts, which made only small outputs, were operated the whole or a part of the year in Alaska in 1912—five more than in 1911. Work was also done on many gold prospects, a few of which produced some gold as an incident to the development work. Of the producing mines, 7 were in southeastern Alaska, 3 on Prince William Sound, 3 on Kenai Peninsula, 3 in Willow Creek district, 1 in southwestern Alaska, 1 in the Innoko district, and 6 at Fairbanks.

The total copper production up to the close of 1912 was 90,293,477 pounds, valued at $13,570,225. There were 8 productive copper mines in 1912, the same number as in 1911. Of these, 3 were in the Ketchikan district, 4 on Prince William Sound, and 1 in the Kotsina-Chitina district. In addition to the 8 productive mines, there were some small shipments of copper ore from several properties which are being developed.

The ore output of all the lode mines in 1912 was 1,855,266 short tons, as against 1,663,379 short tons in 1911. Of the increase, 167,410 tons is to be credited to the gold mines and 24,477 to the copper mines. Of siliceous ores, 1,761,814 short tons were mined, of which 1,619,469 were from the three mines of the Treadwell group. The average gold and silver extraction per ton from all siliceous ores was valued at $2.85. For the 142,345 short tons of ore other than from the Treadwell group the value of the total gold and silver recovery was $930,956. This is over 18 per cent of the value of the total gold and silver production from all siliceous ores.

The total output of copper ore was 93,452 short tons, which yielded an average value of $4.11 a ton in gold and silver, and 15.64 per cent of copper. The large average copper percentage is due to the very high-grade ore shipped from the Bonanza-Kennicott mine.

It is estimated that since mining began in 1880 the Alaska gold placers have yielded 7,488,491 fine ounces of gold, valued at $154,800,848. These mines have also produced 1,652,016 fine ounces of silver, with a commercial value of $960,743.

It is estimated that a total of 720 placer mines were operated in 1912, as compared with 740 in 1911. In 1912 about 6,300,000 cubic yards of gravel were excavated with an average recovery per cubic yard of $1.87, as against 5,790,000 cubic yards excavated in 1911, with an average recovery of $2.17 per yard. Thirty-eight gold dredges were operated in 1912 and 27 in 1911. It is estimated that these dredges in 1912 handled between 3,200,000 and 3,600,000 cubic yards of material and recovered gold to the value of about $2,200,000. The gold output from the dredges in 1911 had a value of about $1,500,000.

REVIEW BY DISTRICTS.

PACIFIC COASTAL BELT.

SOUTHEASTERN ALASKA.

The auriferous lode mines of southeastern Alaska are estimated to have produced gold to a value of $4,418,392 in 1912, as compared with an output of $3,904,217 in 1911. In this region 7 gold lode mines and 3 copper mines were operated in 1912, and 8 gold mines and 3 copper

mines in 1911. Four placer mines were operated in southeastern Alaska in 1912.

Juneau precinct.—Though only 5 gold mines were on a productive basis in the Juneau precinct during 1912, yet the activity in development work was so great as to augur well for the future gold output. The Treadwell group of mines continues to overshadow all other enterprises, but several other properties are being developed on a large scale.

The Treadwell companies completed the installation of the first unit of a hydroelectric plant on Nugget Creek, with an ultimate capacity of 3,000 kilowatts. The central hoisting and crushing plant was practically completed. Changes were also made of pumps and minor machinery from steam to electric power. As usual, the mines of the Treadwell group were operated throughout the year. At the Treadwell mine the ore was taken chiefly from the 750, 1,250, 1,450, and 1,600 foot levels. Much dead work was done on the 1,750-foot level. The ore mined at the Alaska-Mexican was from the 1,100, 1,210, 1,320, and 1,460 foot levels, and considerable dead work was accomplished on the 1,460 and 1,570 foot levels. At the Ready Bullion the ore was taken chiefly from the 1,500-foot, and much work was done on the 2,000-foot level. At the Seven Hundred Foot claim the ore was taken from the 990, 1,100, 1,210, and 1,320 foot levels. On the latter property drifts were also advanced on the 1,570, 1,600, and 1,750 foot levels.

The mill of the Perseverance mine, the property of the Alaska-Gastineau Co., was operated, as in the past, from May to October. The 100-stamp mill and crushing plant was completely destroyed by fire on December 4, 1912. The underground operations consisted in enlarging and retimbering the main adit, drifts, and shaft. About 500 feet of drift was cut. The operations are preparatory to connecting the mine workings with a working and transportation tunnel which is being driven from the Sheep Creek side of the divide, about 2,500 feet of which had been completed at the close of 1912. This tunnel will be 8,000 to 9,000 feet in length and will be about 650 feet below the main level of the Perseverance mine.

Construction work has been started on a milling plant, located near the mouth of Sheep Creek, having a capacity of 6,000 tons a day. The adit is planned to serve to develop not only the Perseverance mine, but also the Silver Queen and other properties lying on the Sheep Creek side of the divide. A hydroelectric plant is to be installed on Salmon Creek.

The 30 stamps of the Alaska-Juneau mine were operated from May to October and were supplied with ore from open cuts. The heading of the new adit tunnel being driven from Gold Creek was advanced to 4,383 feet by the close of the year and is still about 1,700 feet from the ore body. It will undercut the ore body of the Alaska-Juneau about 600 feet below the old workings. The ore is to be trammed from the portal of the adit to a mill which will be erected near tidewater.

The California-Nevada Copper Co., which owns the Ebner mine, on Gold Creek, went into a receivership, and a new company, called the Alaska-Ebner, is said to have been organized to take over the property. Some work was also done on what is believed to be a northwesterly extension of this mineralized zone on the Salmon Creek side of the divide.

At the Petersen property, near Pearl Harbor, north of Juneau, the developments in 1912 consisted of an inclined shaft, sunk 50 feet, together with some open cuts. The driving of the new lower adit near the stamp mill was continued at the Eagle River mine. While some work was undoubtedly done at other properties in the region lying between Juneau and Berners Bay, the writer has no information in regard to it.

It is reported that the driving of the adit on the main level of the Kensington mine at Berners Bay was continued during 1912. Development work was also continued at the Jualin mine, in the same district, and a large air compressor was being installed at the close of the year.

Ketchikan precinct.—No noteworthy advances were made in the Ketchikan precinct in 1912. Only three copper mines were on a productive basis. Two gold mines, which are equipped with stamps, were also operated toward the close of the season, and some gold was probably produced in 1912, but of this there is no definite information at this writing. The Jumbo mine was operated throughout the year, 136 feet of shaft being sunk and the aggregate of drifting amounting to 450 feet.

Operations at the Rush & Brown mine were continued on a productive basis throughout the year. The shaft was sunk to a depth of 184 feet, besides which drifting was continued on the first and second levels, from which the ore was stoped. Some work was done at the Copper Mountain mine, which has long been idle. This consisted of drifts and crosscuts. Some developments were also made at the Red Wing mine. Work was continued on the long adit of the It mine, and some shipments were made. The Mount Andrew mine was idle for most of the year, though plans were made to put it again on a productive basis. Some work was also done on the Victory and on the Sanford groups of copper claims, located near Seal Bay. It is reported that the Northland Development Co. has done considerable underground work on a copper property located on "Big Harbor."[1]

Work was continued on the main level of the Lon de Van property, located on George Inlet. A crosscut was completed in January, 1912, encountering the ore body 2,064 feet from the portal and about 900 feet below the outcrop of the vein. Since then the ore was followed some 1,600 feet by drifting.

The Princeton Mining & Milling Co. continued work on its property located near Dolomi. A 100-horsepower boiler and air compressors were installed. In the fall of 1912 a 10-stamp mill was erected. Late in the year the Goldstream mine, on Gravina Island, was again opened up, and the 5-stamp mill is said to have been operated. Developments were said to have been resumed in 1912 on the Moonshine silver-lead property, which is located on Cholmondeley Sound. Work was continued on the Martin-Bugge, located near Smugglers Cove, on the mainland north of Ketchikan. The developments in 1912 consisted of drifting on the vein on both sides of the adit and in increasing the surface equipment.

Sitka and other precincts.—The Chichagof and Golden Gate mines were combined under one management in 1912. The former was

[1] The location of "Big Harbor" is not known to the writer, but it is probably one of the indentations of Dall Island, in the western part of the Ketchikan district.

operated for the entire year, the latter for the last nine months of the year. A total of 300 feet of sinking, 160 feet of raising, and 2,800 feet of horizontal work was done in these two mines during 1912. It is reported that a discovery of rich gold ore was made by Bernard Hirst in 1912. The locality of this discovery is reported to be near the Chichagof mine.

During 1912 nothing of importance occurred in lode development either in the Porcupine, Skagway, or Wrangell districts. There was, however, considerable lode prospecting in both the Wrangell and the Porcupine districts.

Placer mining.—One mine operating near Juneau and two or three mines in the Porcupine district continue to be the only placer mines in southeastern Alaska. It is reported that some investigations of auriferous gravels on Montana Creek, near Juneau, were made looking to the installation of a dredge. A hydraulic plant was operated on Porcupine Creek and another on Calhoun Creek during the open season of 1912. Some work was also done on other creeks of the district, notably on Glacier Creek, where preparations were made to install a hydraulic plant.

Beach mining.—About 15 or 20 men were engaged in beach mining in the Yakataga district. The hydraulic plant on White River, in this district, was not operated in 1912, work on this property being concentrated on extending the ditch line. The beach placers of Kodiak Island were also worked in a small way during 1912.

PRINCE WILLIAM SOUND.

Much advance was made in developing the mineral resources of Prince William Sound during 1912. Three copper mines made regular shipments of ore, and small test shipments were made from several other properties under development. Only one gold mine was operated on any considerable scale, but in the aggregate considerable ore was recovered from other properties incidental to mining operations. It is estimated that the mineral production of Prince William Sound in 1912 had a value of $1,150,000, compared with a value of $1,000,000 for 1911.

The Three Friends, the Beatson-Bonanza, and the Ellamar copper mines were operated on a productive basis, and test shipments of ore were made from other properties. The Cliff mine near Valdez was operated throughout the year, the workings having reached a depth of 500 feet. Among the several auriferous lodes where important advances were made during the year were the Alice, the Thompson & Ford, the Mayfield, and the Rutherford, in the Valdez district. Promising discoveries of auriferous quartz veins were also made in the Port Wells district, where several properties were developed in 1912. The Midas copper mine, near Valdez, was opened up and some ore was shipped.

KENAI PENINSULA.

No lode properties were developed on a large scale in Kenai Peninsula during 1912, yet in the aggregate considerable work was accomplished. Three small stamp mills were operated by the Kenai Alaska, the Primrose, and the Skeena-Lechner mining companies for a part of the summer season. A small prospecting mill and two

arrastres also contributed something to the gold output. The total lode gold production of 1912 was less than $20,000 in value. The dead work accomplished was considerable in spite of the fact that, as indicated above, but few of the mines were on a productive basis.

Placers.—Mining continued on the Kenai Peninsula about on the same scale as in previous years. About 20 to 25 mines were operated, of which 8 or 10 were hydraulic mines. The largest of the latter is located on Crow Creek, north of Turnagain Arm, and is not on Kenai Peninsula proper. One dredge was operated on Kenai River, besides which considerable prospective dredging ground on another property was tested with a churn drill.

SOUTHWESTERN ALASKA.

As in previous years, the Apollo mine, on Unga Island, was the only productive lode property in southwestern Alaska. Prospecting was, however, continued at several other localities, notably in the Iliamna region. A little coarse gold was taken from the placers of Portage Creek, which flows into Lake Clark from the west. In the Mulchatna region the prospectors directed their attention to the benches, and encouraging results are reported from Bonanza and Ptarmigan creeks.

COPPER RIVER REGION.

Kotsina-Chitina district.—The Kennicott-Bonanza mine is the only one in the Kotsina-Chitina district from which shipments were made in 1912, but a large amount of development work was done on other properties. The concentrator installed in 1911 at the Bonanza mine was operated during 1912. At the east end of the field work was continued on the Mother Lode, Nikolai, and Westover properties and also on a property located on an island in the Kennicott Glacier. Prospecting and developing were especially active in the vicinity of Kuskulana River. Here the largest operations were those of the Great Northern Development Co., which completed about 5,000 feet of development work. The Alaska Consolidated Copper Co. carried on development work on Nugget Creek and on the Rarus group of claims. The Alaska United Copper Exploration Co. continued work on the Blackburn group of claims, located on Porcupine Creek. The Hubbard-Elliott Copper Co. continued operations, notably on the Albert Johnson claim. In addition, a large number of claims were being opened in the Kuskulana region during the summer of 1912. This field is now readily accessible from the railway, and a branch has been surveyed which would permit the shipment of ore.

Placer mining.—The season in the Nizina placer district was successful, except for the floods which occurred in the latter part of the summer and caused much damage to the two large plants there installed. The plant on Chititu Creek was, however, put into working order again before the close of the season. There was also a little placer mining in the Bremner River region. Seven placer mines were operated in the Chistochina district in 1912.

SUSITNA BASIN.

Willow Creek district.—Three quartz mines—the Gold Bullion, the Alaska Free Gold, and the Gold Quartz—were operated in the Willow Creek district in 1912. Each of these properties is equipped with a

small mill which operated during the summer season, crushing in all about 3,000 tons of ore and producing gold to the value of about $100,000. The properties have thus far been operated only on a small scale, chiefly owing to the high cost of transportation. Therefore, perhaps the most important event of the year was the completion of a wagon road up the Little Susitna, rendering the eastern part of the district accessible. Plans are now being made looking to larger developments by continuing certain properties and developing hydroelectric power on the Little Susitna. Several discoveries of gold-bearing quartz are said to have been made in 1912. Noteworthy is one reported to have been made by A. C. Shough, described as a quartz vein carrying high values in gold, and located in the eastern side of the upper Little Susitna basin.

Two discoveries of metalliferous lodes which may prove important have been reported in the region tributary to the Willow Creek district. One of these is an occurrence of copper ore (bornite) on the south side of Sheep Mountain, in the upper Matanuska basin. The other is located on Peters Creek, a tributary from the southeast to Knik Arm. These occurrences are about 20 miles from tidewater.

Yentna district.—The season of 1912 was a prosperous one in the Yentna district. Water was abundant; in fact, at times some of the streams were so flooded as to interfere with mining operations. It is estimated that about 100 men were engaged in mining. The most important operations were on Thunder, Dollar, Nugget, Willow, and on several other tributaries of Cache and Peters creeks. Plans have been made for installing a hydraulic plant on Thunder Creek. Some placers occurring in elevated gravels on Dollar Creek were developed, it is reported, with good results. Some mining was also done on Twin, Mills, and other creeks of the western end of the Yentna district.

Other placer districts.—In 1912 a little placer mining was also done on Willow Creek and Caribou Creek, tributary to the upper Matanuska. A few small plants were also operated on Valdez Creek, which lies in the headwater region of Susitna River. A number of claims that have been worked on Valdez Creek in previous years were idle in 1912, pending the launching of a larger mining enterprise.

YUKON BASIN.

It is estimated that the value of the gold production of the Alaska Yukon was $8,645,000 in 1912, compared with $9,050,000 in 1911. This decrease is due to the falling off of the output from the Fairbanks and the Hotsprings districts, for the other Yukon camps either held their own or somewhat increased their output as compared with 1911. Probably the most encouraging features of the year's activity was the definite proof of the presence of workable placers in the Ruby district.

Fairbanks district.—Although the output from the Fairbanks placers has decreased, there was far greater activity in lode mining and prospecting than in 1911. Lode prospecting has continued with increasing activity during the year, and probably more than 200 men were engaged in this work. Most of the operations were conducted on a small scale, and the total output of gold was not large, but a very considerable amount of development work was accomplished

during the year. In 1912 six stamp mills, aggregating 24 stamps, were operated for a part of the year, and six other mills were being installed in the late summer, and some of these were put into commission before the close of the year. Statistics at hand indicate that the average recovery of free gold from these operations is about $50 a ton. In only two places are the concentrates being saved, though they undoubtedly contain additional gold.

The Fairbanks district continues to lead in the production of placer gold, though the value of the output in 1912 was only $4,150,000, compared with $4,500,000 in 1911. The new discoveries in this field were principally those on creeks which have already yielded some gold. The most important was on Eva Creek. The work of the year has also considerably increased the area known to be underlain by workable gravels in the Chatanika Flats, near the mouths of Dome and Cleary creeks. Additional gold-bearing gravels are said to have been found on Fairkanks Creek. The Fairbanks Creek dredge was operated throughout much of the open season. The gold produced at Fairbanks came chiefly from Goldstream Creek, the lower parts of Dome and Cleary creeks, and Ester, Eva, and Fairbanks creeks. It is estimated that between 130 and 140 different plants were operated in 1912. Summer operations were much in excess of those of the winter.

Birch Creek district.—In the Birch Creek district the placer gold was taken chiefly from the mines of Mastodon, Deadwood, Eagle, Mammoth, Switch, and Independence creeks. It is estimated that about 27 mines were worked during the winter and 32 in the summer of 1912. A dredge installed on Mastodon Creek was operated during the summer of 1912. Hydraulic plants were operated on Mammoth, Mastodon, and Eagle creeks. It is estimated that gold to the value of about $325,000 was produced.

Fortymile district.—The Fortymile district had a successful season. Three dredges were operated there during the summer. It is estimated that about 25 mines were operated in the winter of 1912 and about 50 during the summer. Many of these were, however, only small plants. The value of gold output in 1912 was about $230,000.

Ruby district.—Operations in Ruby district were practically confined to six creeks, all lying within a small area about 25 miles south of the town of Ruby, on the Yukon. The creeks on which productive mining has been carried on are Long Creek, Upper Long Creek, Bear Pup, Midnight Creek, Glenn Gulch, and Trail Creek. About 30 claims were worked in this district in 1912 and produced about $170,000 in gold.

Innoko-Iditarod region.—About 24 claims, located on five creeks and employing 140 men, were worked in the Innoko district during 1912. No new discoveries were made. In the Iditarod district Otter and Flat creeks continue to be the most important producers of placer gold. Work was also done on Chicken, Willow, and Happy creeks, and a little mining was carried on about Moore Creek, located about 30 miles farther east. A dredge was installed on the upper part of Flat Creek during the winter of 1912 and was operated for the latter part of the open season. It is estimated that 34 mines

were operated in the Iditarod district in 1912. These were distributed on 6 creeks and employed about 650 men. Of these plants, 1 is a dredge, 18 are equipped with steam machinery, and the rest are operated by manual methods. The gold production of 1912 is estimated to have a value of $3,000,000, that of 1911 was valued at $2,900,000.

During the summer of 1912 gold was discovered on Fox Gulch, a tributary of Cripple Creek, 30 miles northeast of Ophir, which created considerable local excitement. About 100 men are said to be prospecting in this field. It is reported also that some workable placers were found on Mud River, a northwesterly tributary of the Innoko.

Other districts.—The value of the gold output from the Hot Springs district is estimated at $400,000, compared with $785,000 in 1911. Some important placer discoveries were made in 1912 on Hammond River, in the Koyukuk district. Mining also continued in other parts of Koyukuk district, and the total gold production of 1912 is estimated to have a value of $240,000. No important progress was made in the Rampart, Kantishna, Bonnifield, or Tenderfoot districts during 1912. The output from these camps was about the same as in the previous year and totaled in value about $100,000.

KUSKOKWIM REGION.

Auriferous gravels have been found in many places within the lower Kuskokwim region, but so far as has been learned, no very rich deposits have been found. Placer mining on a small scale has, however, been carried on, notably in the Anniak River, Tuluksak River, and Goodnews Bay regions. The value of the total gold production to date is estimated to be between $75,000 and $100,000. In 1912 there were probably some 200 men in this general field, most of whom were engaged in prospecting rather than in productive mining. So far as can be learned (for the district has not been examined by a geologist), considerable low-grade placer ground has been found which would not yield profitable returns under present costs and methods of mining. Some richer gravels have also been found which have yielded returns to the ordinary manual methods of operation. Plans have also been formulated for installation of dredges and hydraulic plants with the purpose of exploiting some of the gravels of low gold tenor.

NORTHWESTERN ALASKA.

Seward Peninsula.—The value of the gold output of the Seward Peninsula in 1912 is estimated to be $3,000,000; that of 1911 was $3,100,000. This small reduction, as compared with the production of 1911, is very significant, in view of the fact that all forms of mining except dredging were much hampered by low-water conditions during the first part of the mining season. Dredging was also retarded by the unusual lateness of the spring. These conditions considered, the gold output was remarkably large, and there is reason to believe that it has reached its minimum for many years to come.

The value of the output from the various districts in 1912 is estimated as follows: Nome, $1,150,000; Solomon and Casadepaga,

$750,000; Council, $600,000; Fairhaven, $290,000; Kougarok, $160,000; and Port Clarence, $50,000. It is of importance to the mining industry to know the proportion of gold derived from each form of mining. Neglect on the part of some of the operators to report production makes it possible only to approximate these data. The best information available indicates that gold to the value of about $1,700,000 was recovered by dredging, about $1,040,000 by various open-cut mining methods, including some hydraulicking, and about $260,000 by deep mining methods. This is in strong contrast to the conditions a few years ago, when several million dollars worth of gold was won annually by underground mining, and the output of the dredges was but a small fraction of the total.

In 1912 there were 31 gold dredges in operation in the Seward Peninsula, compared with 22 in 1911. Three dredges, chiefly small ones, built prior to 1912, were not operated. The 11 new dredges installed in 1912 were only operated for a part of the season, some making only test runs. Four dredges under construction were not completed in time for operating. In addition to these, a number of other dredging enterprises are under way. Most of the dredges which were completed in time began work about the middle of June, but some were delayed on account of the lateness of the season. The usual close of the dredging season is about the middle of October, but some were operated for a month or more longer. Of the dredges operated, 9 were located in the region tributary to Nome, 9 in the Solomon River basin, 2 in the Casadegaga, 6 in the Council, 2 in the Kougarok, 2 in the Fairhaven, 1 in the Port Clarence district. Eighteen of the dredges are reported to have a bucket capacity of less than 2 cubic feet, 6 a capacity of 3 to 3½ cubic feet, 3 a capacity of 5 cubic feet, and 4 a capacity of 9 to 10 cubic feet.

The daily capacity of these dredges averages about 1,000 cubic yards. It is estimated that between 2,500,000 and 3,000,000 cubic yards of gravel were handled by the dredges. If these figures are correct, it would indicate an average gold recovery of from 52 to 64 cents per cubic yard. In considering these values it should be noted that the average recovery per cubic yard is increased by the large output of a comparatively few dredges which are working on very rich ground.

Worthy of special note is the discovery of placer gold in the southeastern part of Seward Peninsula, where there has been but little mining. In 1912 some mining was done on Placer Creek, a tributary of Kobuk River. Good prospects are also said to have been found on Sweepstakes Creek, another tributary of the Kobuk. Placer gold has also been found on two small creeks in the Darby Mountains, not far from Golovin Bay.

Kobuk district.—During 1912 mining was continued in a small way in the Dahl and Squirrel River regions of the Kobuk district. The information at hand indicates that no important developments were made. It is reported that workable placers have been found on Lynx Creek. This stream flows into Kogoluktuk River, which in turn is tributary to Kobuk River, about 3 miles east of Shungnak.

ARIZONA.

By V. C. Heikes.

PRODUCTION.

For the calendar year 1912, the gold, silver, copper, lead, and zinc contained in bullion, ore of shipping grade, and concentrates from the combined output of 445 producers in Arizona, had a value of $67,050,784, as against an output valued at $44,157,223 made by 397 producers in 1911. The difference of $22,893,561 in these totals was caused mainly by the increased copper production. The increase in value for 1912 was as follows: Gold, from $3,430,503 in 1911 to $3,762,210, an increase of $331,707, in 1912; silver, from $1,736,583 to $2,146,588, an increase of $410,005; copper, from $38,267,692 to $60,231,377, an increase of $21,963,685; zinc (spelter), from $260,090 to $604,319, an increase of $344,229. Statistics showing the total metallic output since 1904, with increase and decrease for 1912, are given in the following table:

Number of producers, quantity of ore sold or treated in Arizona in 1904–1912, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	117	2,305,938	$3,478,532	2,314,940	199,481,044	1,779,967	.....	$29,816,840
1905	134	2,678,059	2,799,214	2,605,712	228,418,679	4,940,910	140,000	40,246,861
1906	171	3,585,089	2,964,683	3,026,438	266,831,864	5,638,735	.....	56,812,355
1907	437	3,567,133	2,617,313	2,511,897	254,879,489	4,660,684	228,490	55,511,560
1908	310	3,696,938	2,431,977	2,808,450	285,858,133	3,008,583	678,446	41,811,975
1909	268	4,029,955	2,737,500	2,601,161	303,899,461	3,098,083	5,977,237	44,053,023
1910	373	3,914,969	3,149,366	2,566,528	297,491,151	2,696,998	5,484,899	42,731,519
1911	397	4,567,139	3,430,503	3,276,571	306,141,538	10,274,552	4,562,984	44,157,223
1912	445	6,840,082	3,762,210	3,490,387	365,038,649	6,806,443	8,758,243	67,050,784
Increase (+) or decrease (—) in 1912		+2,272,943	+331,707	+213,816	+58,897,111	—3,468,109	+4,195,259	+22,893,561

ORE PRODUCTION IN 1912.

Producers in Arizona mined 6,840,082 tons of ore in 1912, an increase of 2,272,943 tons over the output of 1911. The total average value per ton increased from $9.66 to $9.80, which appears to be about the normal value. Affecting these averages is the mining of large quantities of low-grade copper ores which show an average recovery value of about $4.50 per ton, which is principally for the copper content; as a rule they contain very little gold and silver. The average value of the ore output in gold and silver decreased from $1.13 in 1911 to 86 cents in 1912, the most noticeable decrease appearing in Gila County, probably caused by the increase in quantity of low-grade copper ore produced at the Miami mines. The increase in ore production was mainly in copper ores, siliceous ores, zinc ores, and copper-lead ores. Dry or siliceous ores increased from 243,900 tons in 1911 to 250,142 tons in 1912. Under this classification is included 210,934 tons of siliceous gold ores, averaging per ton $10.54

in gold and 0.24 ounce of silver. The gold ores were mainly from Mohave, Yavapai, and Maricopa counties. Gold and silver ores, dry or siliceous in character, aggregated 38,779 tons and averaged $2.27 in gold and 7.72 ounces of silver, 1.79 pounds of copper, and 3.46 pounds of lead per ton, and were produced in Cochise, Yavapai, and Santa Cruz counties chiefly. The siliceous silver ores produced in 1912 aggregated 429 tons, averaging per ton $0.08 in gold, 53.78 ounces of silver, 10.86 pounds of copper, and 2.83 pounds of lead. These ores of silver were produced principally in Cochise and Gila counties. The copper ore mined by 199 producers aggregated 6,542,154 tons, against 4,274,209 tons mined by 109 producers in 1912. In 1912, 39.85 per cent of the copper ore, or 2,607,659 tons, was mined from low-grade deposits of disseminated copper in schists and porphyry at Ray and in the Globe district. The copper ores of Greenlee County might be classified with these ores, and if added to the Ray and Miami output of porphyry ores, would make an aggregate of 4,350,533 tons of disseminated ores with a yield of 145,601,651 pounds, or nearly 40 per cent of the State yield of copper. All of the low-grade copper ores produced were concentrated and the concentrates smelted. The remainder of the copper ore mined was directly smelted and aggregated 2,106,929 tons, averaging $0.55 in gold and 1.04 ounces of silver per ton, 5.31 per cent of copper, and $18.72 per ton in value. These copper ores of smelting grade were mostly sulphides and aggregated 1,228,389 tons in quantity, averaging per ton 62 cents in gold, and 1.24 ounces of silver, and contained an average of 5.31 per cent of copper. The oxidized copper ores, 878,540 tons in quantity, averaged 20 cents in gold and 0.75 ounce of silver per ton, and 5.32 per cent of copper. The output of lead ores of smelting grade decreased from 21,190 tons mined in 1911 to 20,696 tons mined in 1912. Of this kind of ore, the sulphides predominated and aggregated 13,205 tons, averaging $7.23 in gold and 32.15 ounces of silver per ton, and 0.16 per cent of copper, and 13.36 per cent of lead. The oxidized ores of lead, largely iron oxides with lead carbonates, aggregated 7,491 tons and averaged $3.92 in gold and 22.50 ounces of silver per ton, and 0.21 per cent of copper, and 6.79 per cent of lead. The output of zinc ores of shipping grade increased from 2,106 tons mined in 1911 to 4,264 tons mined in 1912. The sulphide zinc ores were produced in the largest quantities, aggregating 4,031 tons, from which was recovered an average of $5.78 in gold and 7.94 ounces of silver per ton, and they yielded 0.99 per cent of copper, 2.63 per cent of lead, and 34.03 per cent of zinc (spelter). The oxidized zinc ores aggregated 233 tons and yielded 29.08 per cent of zinc (spelter). Sulphide lead-zinc ores, none of which was produced in 1911, aggregated 528 tons in 1912, and averaged 62 cents in gold and 17.61 ounces of silver per ton, and 0.64 per cent of copper, 15.93 per cent of lead, and 30.14 per cent of zinc (spelter). The production of copper-lead ores increased from 129 tons in 1911 to 315 tons in 1912. The sulphides, of which 269 tons were produced, predominated, averaging $5.99 in gold and 22.93 ounces of silver per ton, and 4.25 per cent of copper, and 17.92 per cent of lead. The oxidized copper-lead ores, aggregating 46 tons, averaged $2.48 in gold and 272 ounces of silver per ton and 4.19 per cent of copper, and 19.93 per cent of lead. The total tonnage of ore

produced, based on the quantity of crude ore mined and sold or treated in Arizona in 1912, is shown in the following table:

Output of ore and production of metals in Arizona in 1912, by kinds of ore.

Source of production.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	51	.....	2,082.35	388	.....	.....	.....
Dry or siliceous ore	140	250,142	112,067.76	373,255	87,426	215,962	.....
Copper ore	199	6,542,154	57,507.81	2,378,593	364,638,161	16,065	.....
Lead ore	63	20,960	6,363.49	599,110	73,896	4,555,651	.....
Zinc ore	4	22,321	3,126.18	87,461	201,272	585,840	7,657,100
Copper-lead ore	8	315	84.03	18,680	26,731	114,748	.....
Lead-zinc ore	4	4,190	765.29	32,900	11,163	1,318,177	1,101,143
Total	.....	6,840,082	181,996.91	3,490,387	365,038,649	6,806,443	8,758,243

Subdivision of tonnage of ore sold or treated in Arizona in 1912, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	24,755	1,337,296	19,013	35	59	.....	1,381,158
Coconino	.....	168	.....	.....	.....	.....	168
Gila	204	1,449,805	192	.....	.....	.....	1,450,201
Graham	50	3	30	.....	.....	.....	83
Greenlee	4,031	1,742,874	.....	.....	.....	.....	1,746,905
Maricopa	19,735	388	.....	.....	.....	.....	20,123
Mohave	175,486	1,190	511	22,088	.....	3,662	202,937
Pima	2,278	27,003	97	198	75	.....	29,651
Pinal	1,600	1,575,551	31	.....	29	.....	1,577,211
Santa Cruz	3,047	10,972	68	.....	152	43	14,282
Yavapai	18,339	386,414	815	.....	.....	485	406,053
Yuma	617	10,490	203	.....	.....	.....	11,310
Total	250,142	6,542,154	20,960	22,321	315	4,190	6,840,082
Value per ton in gold and silver	$10.18	$0.41	$23.85	$5.30	$41.98	$8.60	$0.86

GOLD.

The production of gold in Arizona in 1912 was 181,996.91 ounces, valued at $3,762,210, an increase in value of $331,707. Of this output, 2,082.35 ounces came from placers, 112,067.76 ounces from dry or siliceous ore, 57,507.81 ounces from copper ore, and 6,363.49 ounces from lead ore. From bullion recovered in gold and silver mills, 102,244.75 ounces were produced; concentrates yielded 10,276.48 ounces, and crude ore sent to smelters contained 67,086.86 ounces. The largest production of gold was made in Mohave County, its mines yielding 91,870.46 ounces, valued at $1,899,131, or half the State total. The output in 1911 was 74,868.20 ounces, valued at $1,547,663. Copper ores mined chiefly in the Warren district of Cochise County, and siliceous ores from the San Francisco district in Mohave County were the chief sources of gold. The heaviest decrease of gold was in Yavapai County; there was decrease also in Yuma, Gila, and Pinal counties. Through the amalgamation process

11,433.20 ounces of gold were won, and by the cyanidation process on ore and old tailings 90,811.55 ounces of gold were produced. The gold content in crude dry or siliceous ores shipped directly to the smelters averaged $10.02 per ton; in copper ores, 55 cents; in lead ore, $6.09; in zinc ore, $5.43; in copper-lead ore, $5.51; and in lead-zinc ore, 74 cents. Dry or siliceous concentrate obtained from gold and silver mills contained $135.15 in gold per ton; the same kind of concentrate produced at concentration mills contained $25.52 in gold. Copper concentrate contained 6 cents per ton; lead concentrate, $63.34; zinc concentrate, $5.51; and lead-zinc concentrate, $6.72. Placers in Maricopa, Mohave, Pima, Pinal, Yavapai, and Yuma counties yielded $43,046 in gold, as against $23,641 in 1911.

Source of gold production in Arizona, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	.....	718.13	38,145.05	5,172.88	.....	0.43	.....	44,036.49
Coconino	.....	.....	.48	.....	.....	.....	.....	.48
Gila	.....	84.03	1,465.13	92.64	.....	.....	.....	1,641.80
Graham	.....	40.79	.02	119.26	.....	.....	.....	160.07
Greenlee	.....	911.87	840.27	.....	.....	.....	.....	1,752.14
Maricopa	65.26	14,240.07	5.16	.....	.....	.....	.....	14,310.49
Mohave	1.69	87,520.49	16.34	459.47	3,126.18	.....	756.29	91,870.46
Pima	215.80	143.62	83.16	8.71	.....	6.24	.....	457.53
Pinal	38.17	188.72	213.18	4.01	.....	3.00	.....	447.08
Santa Cruz	.....	1,438.33	32.46	.09	.....	74.36	.....	1,545.24
Yavapai	770.27	5,720.88	16,353.00	477.84	.....	.....	19.00	23,340.99
Yuma	991.16	1,060.83	353.56	28.59	.....	.....	.....	2,434.14
Total	2,082.35	112,067.76	57,507.81	6,363.49	3,126.18	84.03	765.29	181,996.91

SILVER.

The silver production of Arizona in 1912 was 3,490,387 ounces, valued at $2,146,588, and showed an increase of 213,816 ounces in quantity and of $410,005 in value. Cochise County produced 1,962,644 ounces, against 1,946,319 in 1911. Yavapai County produced 748,872 ounces in 1912, against 764,744 ounces in 1911. Of the total output 2,378,593 ounces came from copper ore, 373,255 ounces from siliceous ore, and 599,110 ounces from lead ore. Bullion produced at gold and silver mills yielded 45,660 ounces of silver in 1912, concentrate produced 387,159 ounces, and crude ore sent to smelters contained 2,982,049 ounces. The copper ores milled produced 182,570 ounces, or an average of 0.46 ounce per ton, from concentrates in 1912, against 184,365 ounces, or an average of 0.60 ounce per ton, in 1911. Lead concentrates contained 6,028 ounces of silver, or an average of 68.50 ounces per ton, against 47,563 ounces of silver, or an average of 12.68 ounces per ton, in 1911. Of the crude ores shipped direct to the smelters, the copper ores produced 73 per cent of the silver, or 2,185,640 ounces in quantity, an average per ton of 1.04 ounces. The lead ores shipped contained an average of 28.66 ounces per ton, or a total of 593,082 ounces.

Source of silver production in Arizona, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	.....	76,323	1,397,440	488,385	.....	496	.....	1,962,644
Coconino	.....	.....	83	.....	.....	.....	.....	83
Gila	.....	7,515	255,419	2,007	.....	.....	.....	264,941
Graham	.....	14	9	399	.....	.....	.....	422
Greenlee	.....	55,216	22,527	.....	.....	.....	.....	77,743
Maricopa	11	5,749	28,025	.....	.....	.....	.....	33,785
Mohave	.....	45,709	1,367	16,203	87,461	.....	23,603	174,343
Pima	38	1,738	33,579	4,174	.....	2,427	.....	41,956
Pinal	6	40	109,686	737	.....	1,433	.....	111,902
Santa Cruz	.....	40,973	8,076	1,573	.....	14,324	158	65,104
Yavapai	130	137,643	520,540	81,420	.....	.....	9,139	748,872
Yuma	203	2,335	1,842	4,212	.....	.....	.....	8,592
Total	388	373,255	2,378,593	599,110	87,461	18,680	32,900	3,490,387

COPPER.

Arizona remained the leading copper-producing State and increased the production of that metal from 306,141,538 pounds, valued at $38,267,692 in 1911, to 365,038,649 pounds, valued at $60,231,377 in 1912, an increase of 58,897,111 pounds. Increase was made in all the counties except Yavapai and Coconino. Over 61 per cent of the production, or 224,141,378 pounds, came from crude ore shipped to smelters, and 135,666,375 pounds came from concentrates. From old smelter slag treated 5,215,289 pounds of copper were recovered, as against 1,215,948 pounds in 1911; and from old tailings 15,607 pounds were recovered, against 13,644 pounds in 1911. Low-grade copper ores, the so-called disseminated porphyries and schists, which were concentrated, yielded 68,753,553 pounds of copper, against 30,666,515 pounds in 1911. The same class of low-grade copper deposits are found in Greenlee County, embracing the Clifton-Morenci region, which produced 76,848,299 pounds in 1912 and 70,926,330 pounds in 1911. The output of Pinal County, which includes the Mineral Creek or Ray district, increased 21,449,418 pounds. Other large increases were in Gila, Cochise, and Greenlee counties. The mines in Pinal, Gila, and Greenlee counties produced nearly 49 per cent of the total output of copper, or 178,078,963 pounds, and of this total 135,355,124 pounds came from concentrates. Copper ores aggregating 6,542,154 tons were mined in largest quantities in Greenlee, Pinal, Gila, Cochise, and Yavapai counties, in order named, and averaged 55.73 pounds of copper per ton, against 4,274,209 tons and an average of 71.38 pounds per ton mined in 1911. Dry or siliceous ores, aggregating 250,142 tons, yielded an average of 0.35 pound of copper per ton; lead ores, aggregating 20,960 tons, yielded 3.52 pounds per ton; and lead-zinc ores, aggregating 4,190 tons, averaged 2.66 pounds per ton. Copper-lead ores mined in Cochise, Pima, Pinal, and Santa Cruz counties yielded from 315 tons of ore, an average of 84.86 pounds per ton.

Source of copper production in Arizona, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	3,845	147,581,858	63,736	.....	5,222	.....	147,654,661
Coconino	.....	9,348	.....	.....	.....	.....	9,348
Gila	610	63,966,489	2,324	.....	.....	.....	63,969,423
Graham	.....	711	445	.....	.....	.....	1,156
Greenlee	201	76,848,098	.....	.....	.....	.....	76,848,299
Maricopa	4,794	73,403	.....	.....	.....	.....	78,197
Mohave	2,513	435,009	955	201,272	.....	4,396	644,145
Pima	20	2,104,571	2,269	.....	5,977	.....	2,112,837
Pinal	.....	37,257,986	6	.....	3,249	.....	37,261,241
Santa Cruz	57,684	1,850,367	1,377	.....	12,283	391	1,922,102
Yavapai	17,759	34,016,197	2,673	.....	.....	6,376	34,043,005
Yuma	.....	494,124	111	.....	.....	.....	494,235
Total	87,426	364,638,161	73,896	201,272	26,731	11,163	365,038,649

LEAD.

The lead production of Arizona in 1912 was about a third less than in 1911, decreasing from 10,274,552 pounds, valued at $462,355, in 1911, to 6,806,443 pounds, valued at $306,290, in 1912. About 55 per cent of the lead output originated in Cochise County, where there was a decrease of 3,130,521 pounds compared with 1911. The mines of Mohave County also decreased in lead output, from 2,591,589 pounds in 1911 to 1,937,031 pounds in 1912. Crude ore shipped direct to smelters contained 5,075,201 pounds, and the concentrates produced contained 1,731,242 pounds. At mills using concentration methods only 88 tons of lead concentrates were produced, containing 11,496 pounds of lead. Copper concentrates yielded no lead. Dry or siliceous concentrates yielded 195,858 pounds of lead. Zinc concentrates aggregating 7,524 tons, containing 373,893 pounds of lead, and 2,295 tons of lead-zinc concentrates, containing 1,149,995 pounds of lead, were sold to eastern plants from which the residues were shipped to western lead works.

Source of lead production in Arizona, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	16,398	535	3,740,596	.....	19,338	.....	3,776,867
Gila	79	267	47,003	.....	.....	.....	47,349
Graham	.....	.....	9,281	.....	.....	.....	9,281
Maricopa	79,230	58	.....	.....	.....	.....	79,288
Mohave	366	.....	200,830	585,840	.....	1,149,995	1,937,031
Pima	.....	686	55,732	.....	27,878	.....	84,296
Pinal	.....	.....	25,715	.....	20,615	.....	46,330
Santa Cruz	6,985	775	34,851	.....	46,917	10,476	100,004
Yavapai	112,904	13,744	197,473	.....	.....	157,706	481,827
Yuma	.....	.....	244,170	.....	.....	.....	244,170
Total	215,962	16,065	4,555,651	585,840	114,748	1,318,177	6,806,443

ZINC.

The production of zinc (spelter) in Arizona, which amounted to 8,758,243 pounds, valued at $604,319, in 1912, was 4,195,259 pounds more in quantity and $344,229 greater in value than the output of 1911. Mohave County produced nearly 95 per cent of the State production and Yavapai, Pima, Santa Cruz, and Cochise counties made small productions. Milling plants equipped with concentration devices, both wet and dry, recovered the larger part of the zinc output, which was shipped as concentrate to eastern zinc plants. There were 7,524 tons of zinc concentrate and 2,295 tons of lead-zinc concentrate produced, containing together 5,560,824 pounds of spelter. The output of crude zinc ore, amounting to 4,264 tons, contained 2,879,175 pounds, or 675 pounds per ton.

Source of zinc production in Arizona, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Cochise	23,800	.....	23,800
Mohave	7,521,563	782,899	8,304,462
Pima	111,737	.....	111,737
Santa Cruz	.....	25,539	25,539
Yavapai	.....	292,705	292,705
Total	7,657,100	1,101,143	8,758,243

Zinc ore and concentrates produced from Arizona mines and mills, sold in 1912, and source by counties.

County.	Classification.	Quantity.	Average assay of ore or concentrates.
		Short tons.	*Per cent of zinc.*
Mohave	Sulphide zinc ore	[a] 4,031	37.53
Santa Cruz and Yavapai	Sulphide zinc-lead ore	528	35.45
Cochise and Pima	Carbonate ore	233	36.36
Mohave	Concentrates	[a] 8,591	39.62
Total ore and concentrates	.....	13,383	38.62

[a] Partly estimated; one producer mixes both products for shipment.

MINING INDUSTRY IN 1912.

No new discoveries of any note were made in Arizona in 1912. Copper mining was greatly stimulated by higher prices, and the constantly increasing output of low-grade copper schists and porphyry ores continued to be a feature. These prosperous conditions bring the State of Arizona into the lead of copper-producing States, with a tendency to keep it there. The merging of important copper properties near Globe has brought the Inspiration Consolidated and Southwestern-Miami into prominence as future sources of low-grade copper ores, which are now mined on such a large scale at the Ray mines in Pinal County and the Miami mines in Gila County. Low-grade copper ores are under development in Yavapai County by the Bagdad Copper Co., and prospecting for higher grade deposits continues in the Pioneer district of Pinal County, at Ajo in Pima County,

and in the Palmetto district of Santa Cruz County. The Courtland mines were reopened in July to take advantage of a profitable copper market, which allowed the mining of the oxidized copper ores and helped furnish a supply to supplement the diminishing reserves in the Bisbee mines. The Commonwealth mine at Pearce was under development and its operators should be milling ore in their new 30-stamp mill in 1913. Another interesting feature of the industry was the shipment of old Commonwealth mill tailings to the smelters at Douglas. A contract was made by the Congress mine owners with the smelters in Yavapai County to utilize the Congress tailings, of which it is reported 850,000 tons are available, averaging $1.40 in gold and silver. A railroad is being constructed from Cedar Glade to Verde Valley, where the new smelter of the United Verde Copper Co. is under construction. The railroad will take the place of the narrow-gauge line from Jerome Junction on the Prescott and Phoenix branch.

REDUCTION MILLS.

There were 68 milling plants operating in 1912, some of the plants for only a short period, others the entire year. Twenty-eight plants used the amalgamation method, 11 amalgamation and concentration, and 1 amalgamation and cyanidation. Eight were straight cyanide mills and 16 were straight concentration mills. Arrastres were used on small quantities of ore by 4 operators. Only 198,262 tons, or about 3 per cent, of the total ore mined in Arizona was treated by the amalgamation and cyanidation processes. Of the ore milled, 28,028 tons were treated by amalgamation and yielded 11,433.20 ounces of gold and 2,922 ounces of silver, or an average recovery of $8.47 in gold and 0.10 ounce of silver per ton. The ore treated by cyanidation aggregated 170,234 tons, yielding 90,811.55 ounces of gold and 42,738 ounces of silver, or an average recovery of $10.95 in gold and 0.25 ounce of silver. The total value of the bullion recovered by both processes was $2,141,667.

Quantity of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Arizona in 1912, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Cochise	330	253.57	105	.....	.....	$5,307
Gila	128	21.27	8	.....	146	535
Graham	50	40.79	14	.....	.....	851
Greenlee	90	15.81	7	.....	.....	331
Maricopa	19,696	8,153.86	2,166	2,610.90	682	224,279
Mohave	165,187	309.72	112	87,023.09	41,526	1,830,936
Pima	.....	.....	.....	131.06	66	2,750
Pinal	1,600	188.72	40	.....	.....	3,926
Yavapai	10,782	2,318.68	426	782.95	271	64,545
Yuma	399	130.78	44	263.55	47	8,207
Total	198,262	11,433.20	2,922	90,811.55	42,738	2,141,667

Plants equipped for the concentration of low-grade ore milled 4,327,705 tons, or 63 per cent of the total ore treated. The concentrates produced aggregated 411,627 tons, containing 10,276.48 ounces of gold, or 5.64 per cent of the total gold output; 387,159 ounces, or 11 per cent, of the total silver; 135,666,375 pounds, or 37 per cent, of the total copper; 1,731,242 pounds, or 25 per cent, of the total lead; and 5,560,824 pounds, or 63 per cent, of the total zinc (spelter)—valued in all at $23,297,092, or an average of $56.60 per ton. Copper concentrates aggregating 400,134 tons comprised 97 per cent of the tonnage of the total concentrates produced. The two tables following give the quantity of ore concentrated and of concentrates with their metallic content by counties; also the production by kinds of concentrates and the averages for 1911 and 1912 compared:

Mine production of gold, silver, copper, lead, and zinc from Arizona concentrates in 1912, by counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Gila	1,210,366	91,810	685.46	124,350	40,755,232	.....	.....	$6,815,258
Greenlee	1,511,093	212,898	502.10	14,244	58,539,890	.....	.....	9,678,221
Maricopa	.....	375	3,388.80	2,873	4,669	79,230	.....	76,155
Mohave	21,719	9,819	2,752.71	79,072	125,688	1,523,888	5,560,824	578,544
Pima	3,820	191	14.50	763	151,794	.....	.....	25,815
Pinal	1,571,900	95,236	1.46	43,278	36,060,002	.....	.....	5,976,546
Santa Cruz	1,532	226	365.48	8,876	13,315	3,883	.....	15,386
Yavapai	7,275	1,072	2,565.97	113,703	15,785	124,241	.....	131,167
Total	4,327,705	411,627	10,276.48	387,159	135,666,375	1,731,242	5,560,824	23,297,092
Subdivision by kinds of concentrates:								
Dry or siliceous	.....	1,586	6,052.10	119,489	33,675	195,858	.....	212,964
Copper	.....	400,134	1,202.02	182,570	135,506,918	.....	.....	22,495,771
Lead	.....	88	269.66	6,028	94	11,496	.....	9,814
Zinc	.....	7,524	2,006.44	55,469	121,292	373,893	4,777,925	442,106
Lead-zinc	.....	2,295	746.26	23,603	4,396	1,149,995	782,899	136,437

Kinds of concentrates and average metallic content of each kind produced in Arizona in 1912, compared with 1911.

Kinds of concentrate and source of production.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Gold and silver mills—							
1911	1,885	$60.52	8.92	0.98	.....	.....	$67.71
1912	772	135.15	6.89	.79	7.91	.....	149.38
Concentration mills—							
1911	837	13.75	130.17	.39	1.87	.....	85.42
1912	814	25.52	140.25	1.32	4.52	.....	119.95
Copper:							
Concentration mills—							
1911	304,123	.11	.60	15.64	.....	.....	39.52
1912	400,134	.06	.46	16.93	.....	.....	56.22
Lead:							
Concentration mills—							
1911	3,467	8.68	12.68	.21	33.33	.....	45.93
1912	88	63.34	68.50	.05	6.53	.....	111.52
Zinc:							
Concentration mills—							
1911	4,045	4.91	7.36	.06	1.77	38.13	54.02
1912	7,524	5.51	7.37	.81	2.48	31.75	58.76
Lead-zinc:							
Concentration mills—							
1911	39	25.21	20.51	1.13	30.09	11.43	79.00
1912	2,295	6.72	10.28	.96	25.05	17.06	59.45

SMELTING IN ARIZONA IN 1912.

There were 10 smelting plants operating in Arizona in 1912, 2 at Douglas, in Cochise County; 3 at Clifton and Morenci, in Greenlee County; 2 in Yavapai County, at Humboldt and Jerome; 2 in Gila County, at Globe and Hayden; and 1 in Yuma County, at Swansea. The Swansea smelter was put in operation during July to treat copper ores from the mines in the vicinity of the smelter and fluxing ores secured by exchange from the Humboldt smelter. The Swansea plant consists of one 750-ton water-jacketed blast furnace with two converter stands capable of turning out 45 to 50 tons of metal daily and a 40-ton electrically operated crane. The new smelter[1] at Hayden was completed and put into operation in April, 1912. At this plant there are no blast furnaces and all of the material is smelted in two 19 by 112 foot reverberatories. These furnaces treat the concentrate from the Hayden mill of the Ray mines and put through 300 tons of charge daily. The charge is made up of about 80 per cent of concentrate and 20 per cent of crude ore, the concentrate being roasted prior to charging in the reverberatory furnaces. The matte produced contains 40 to 42 per cent of copper and is blown to blister in two Peirce-Smith converters 10 feet in diameter by 25 feet long, the capacity of each converter being approximately 40 tons of copper per day. The blister copper is shipped to the electrolytic refineries at Baltimore, Md., and Maurer, N. J. Work on new smelting plants continues. One plant is being erected near the old Calumet & Arizona smelter at Douglas, and work is also in progress on new smelting plants for the United Verde in the Verde valley, near Jerome, and for the Arizona Copper Co., at Clifton. These new plants are likely to be in operation in 1913 and their increased activity will probably add to Arizona's copper output. The Humboldt smelter was operated for the greater part of the year, closing in October. Shortage of fluxing ores was said to be the reason for discontinuing operations. At Mayer the Rigby plant was dismantled and most of the machinery moved and put into use at the Humboldt smelter.

Mine production of gold, silver, copper, lead, and zinc from Arizona crude ore shipped to smelters in 1912, by counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	1,297,255	43,536.92	1,892,590	145,321,593	3,776,867	23,800	$26,213,595
Coconino	168	.48	83	9,348	.....	.....	1,603
Gila	180,871	935.07	135,293	20,887,630	47,349	.....	3,551,125
Graham	33	119.28	408	1,156	9,281	.....	3,325
Greenlee	216,591	1,234.23	63,492	17,752,749	.....	.....	2,993,766
Maricopa	427	91.67	28,053	73,528	58	.....	31,284
Mohave	5,869	1,783.25	53,633	518,457	413,143	2,743,638	363,294
Pima	23,631	96.17	41,089	1,961,043	84,296	111,737	362,333
Pinal	3,711	218.73	68,578	1,201,239	46,330	.....	246,985
Santa Cruz	12,750	1,179.76	56,228	1,908,787	96,121	25,539	380,005
Yavapai	387,996	16,903.12	634,342	34,027,220	357,586	292,705	6,390,317
Yuma	10,706	988.18	8,260	478,628	244,170	.....	115,470
Total	2,140,008	67,086.86	2,982,049	224,141,378	5,075,201	3,197,419	40,653,102
Subdivision by kinds of ore:							
Dry or siliceous	7,276	3,527.96	143,358	53,751	20,104	.....	170,868
Copper	2,106,929	56,242.32	2,185,640	223,900,347	16,065	.....	39,451,081
Lead	20,696	6,993.84	593,082	73,802	4,544,155	.....	707,380
Zinc	4,264	1,119.72	31,992	79,980	211,947	2,879,175	264,219
Copper-lead	315	84.02	18,680	26,731	114,748	.....	22,800
Lead-zinc	528	19.00	9,297	6,767	168,182	318,244	36,754

[1] Described by Arthur L. Walker, Eng. and Min. Jour., Jan. 11, 1913, p. 103.

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Arizona, in 1912, compared with 1911.

Kind of crude ore.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	48,037	$1.63	4.49	0.68	0.01	.....	$5.71
1912	7,276	10.02	19.70	.37	.14	.....	23.48
Copper:							
1911	1,655,989	.62	1.18	6.30	.....	.....	17.01
1912	2,106,929	.55	1.04	5.31	.....	.....	18.72
Lead:							
1911	21,190	6.45	29.69	.63	17.61	.....	39.63
1912	20,696	6.09	28.66	.18	10.98	.....	34.18
Zinc:							
1911	2,106	4.31	8.09	.04	2.57	34.89	50.79
1912	4,264	5.43	7.51	.94	2.40	33.76	61.96
Copper-lead:							
1911	129	2.08	39.55	4.11	39.38	.....	68.76
1912	315	5.51	59.30	4.24	18.21	.....	72.38
Lead-zinc:							
1912	528	.74	17.61	.64	15.93	30.14	69.61

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Arizona and shipped to smelters in 1912.

Kind of ore.	Quantity.	Metal content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	7,276	3,527.96	143,358	53,751	20,104	.....	$170,868
Copper:							
Oxidized	878,540	13,901.88	657,172	93,462,150	953	.....	16,112,835
Sulphide	1,228,389	42,340.44	1,528,468	130,438,197	15,112	.....	23,338,245
Lead:							
Oxidized	7,491	1,427.64	168,560	31,656	1,016,513	.....	184,142
Sulphide	13,205	4,666.20	424,522	42,146	3,527,642	.....	523,238
Zinc:							
Oxidized	233	.....	.....	.....	.....	135,537	9,352
Sulphide	4,031	1,119.72	31,992	79,980	211,947	2,743,638	254,868
Copper-lead:							
Oxidized	46	5.73	12,512	3,852	18,341	.....	9,275
Sulphide	269	78.29	6,168	22,879	96,407	.....	13,524
Lead-zinc, sulphide	528	19.00	9,297	6,767	168,182	318,244	36,755
Total	2,140,008	67,086.86	2,982,049	224,141,378	5,075,201	3,197,419	40,653,102

Oxidized and sulphide ore averages per ton, by kinds, produced in Arizona and shipped to smelters in 1912.

Kind of ore.	Quantity.	Average.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces per ton.*	*Fine ounces per ton.*	*Per ct.*	*Per ct.*	*Per ct.*	
Dry or siliceous	7,276	0.48	19.70	0.37	0.14	.....	$23.48
Copper:							
Oxidized	878,540	.01	.75	5.32	.....	.....	18.34
Sulphide	1,228,389	.03	1.24	5.31	.....	.....	19.00
Lead:							
Oxidized	7,491	.19	22.50	.21	6.79	.....	24.58
Sulphide	13,205	.35	32.15	.16	13.36	.....	39.62
Zinc:							
Oxidized	233	.....	.....	.....	.....	29.08	40.14
Sulphide	4,031	.28	7.94	.99	2.63	34.03	63.22
Copper-lead:							
Oxidized	46	.12	272.00	4.19	19.93	.....	201.63
Sulphide	269	.29	22.93	4.25	17.92	.....	50.27
Lead-zinc sulphide	528	.03	17.61	.64	15.93	30.14	69.61
Total	2,140,008	.03	1.39	5.24	.12	.07	19.00

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1912, by counties.

County.	Gold.				Silver.	
	Placers.		Deep mines.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Fine ozs.*	
Cochise			44,036.49	$910,315	1,962,644	$1,207,026
Coconino			.48	10	83	51
Gila			1,641.80	33,939	264,941	162,939
Graham			160.07	3,309	422	259
Greenlee			1,752.14	36,220	77,743	47,812
Maricopa	65.26	$1,349	14,245.23	294,475	33,785	20,778
Mohave	1.69	35	91,868.77	1,899,096	174,343	107,221
Pima	215.80	4,461	241.73	4,997	41,956	25,803
Pinal	38.17	789	408.91	8,453	111,902	68,820
Santa Cruz			1,545.24	31,943	65,104	40,039
Yavapai	770.27	15,923	22,570.72	466,578	748,872	460,556
Yuma	991.16	20,489	1,442.98	29,829	8,592	5,284
Total	2,082.35	43,046	179,914.56	3,719,164	3,490,387	2,146,588

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1912, by counties.

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Cochise	147,654,661	$24,363,019	3,776,867	$169,959	23,800	$1,642	$26,651,961
Coconino	9,348	1,542					1,603
Gila	63,969,423	10,554,955	47,349	2,131			10,753,964
Graham	1,156	191	9,281	418			4,177
Greenlee	76,848,299	12,679,969					12,764,001
Maricopa	78,197	12,902	79,288	3,568			333,072
Mohave	644,145	106,284	1,937,031	87,166	8,304,462	573,008	2,772,810
Pima	2,112,837	348,618	84,296	3,793	111,737	7,710	395,382
Pinal	37,261,241	6,148,105	46,330	2,085			6,228,252
Santa Cruz	1,922,102	317,147	100,004	4,500	25,539	1,762	395,391
Yavapai	34,043,005	5,617,096	481,827	21,682	292,705	20,197	6,602,032
Yuma	494,235	81,549	244,170	10,988			148,139
Total	365,038,649	60,231,377	6,806,443	306,290	8,758,243	604,319	67,050,784

Tons of ore sold or treated, number of deep mines producing, and value of ores in Arizona. in 1911 and 1912, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1912	Increase (+) or decrease (—).	1911	1912	1911	1912	1911	1912
	Short tons.	*Short tons.*						
Cochise	1,381,158	+ 213,921	43	50	$15.99	$19.30	$1.55	$1.53
Coconino	168	— 222	3	2	4.46	9.54	.10	.36
Gila	1,450,201	+ 714,769	43	32	8.61	7.41	.25	.13
Graham	83	+ 50	1	3	39.36	50.32	3.91	42.99
Greenlee	1,746,905	+ 195,685	23	27	5.77	7.31	.06	.05
Maricopa	20,123	+ 867	4	9	5.05	16.48	5.05	15.66
Mohave	202,937	+ 62,535	47	39	14.43	13.66	11.57	9.89
Pima	29,651	+ 21,441	19	53	16.24	13.18	1.12	1.04
Pinal	1,577,211	+ 890,999	21	15	2.93	3.95	.05	.05
Santa Cruz	14,282	+ 13,204	17	30	30.89	27.68	7.72	5.04
Yavapai	406,053	+ 160,888	94	93	22.91	16.22	4.42	2.28
Yuma	11,310	— 1,194	40	41	20.88	11.27	16.40	3.09
Total	6,840,082	+2,272,943	355	394	9.66	9.80	1.13	.86

[a] Value per ton, placer product excluded.

Number of mines in Arizona classified by chief products in 1912, by counties.

County.	Placer.	Gold.	Silver.	Copper.	Gold, silver.	Gold, copper.	Gold, silver, copper.	Gold, silver, lead.	Gold, silver, copper, lead.	Gold, silver, copper, lead, zinc.	Silver, copper, lead, zinc.	Silver, copper.	Silver, lead.	Silver, copper, lead.	Total mines producing.
Cochise	....	....	....	....	7	....	12	2	10	1	....	14	2	2	50
Coconino	....	....	....	....	....	....	1	.....	.....	.....	....	1	....	.....	2
Gila	....	....	1	....	5	....	11	.....	3	.....	....	9	1	2	32
Graham	....	....	....	....	....	....	1	.....	1	.....	....	1	....	.....	3
Greenlee	....	1	....	6	9	....	7	.....	.....	.....	....	4	....	.....	27
Maricopa	5	....	....	1	3	....	3	.....	2	.....	....	.....	....	.....	14
Mohave	1	....	....	....	15	1	5	4	10	2	....	2	....	.....	40
Pima	6	....	....	1	5	....	20	1	9	.....	....	15	....	2	59
Pinal	1	....	....	....	....	....	6	2	2	.....	....	4	....	1	16
Santa Cruz	....	....	....	....	....	....	10	.....	8	.....	1	9	1	1	30
Yavapai	15	....	1	1	27	4	40	2	13	1	....	3	....	1	108
Yuma	23	3	....	1	13	7	8	3	1	.....	....	1	3	1	64
Total	51	4	2	10	84	12	124	14	59	4	1	63	7	10	445

PRODUCTION BY COUNTIES.

COCHISE COUNTY.

Number of producers, quantity of ore sold or treated in Cochise County, Ariz., in 1904–1912, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	14	686,767	$389,437	1,152,466	90,850,611	799,912	.....	$12,440,572
1905	19	950,765	430,388	1,453,312	108,498,440	2,677,980	.....	18,359,810
1906	21	1,195,648	a 618,270	a 1,757,369	130,029,016	2,124,605	.....	27,012,409
1907	49	1,080,986	a 435,560	a 1,411,301	110,024,926	1,654,773	.....	23,459,707
1908	27	1,136,662	a 529,318	a 1,630,749	126,554,764	1,978,097	173,313	18,190,070
1909	38	1,222,095	496,951	1,454,390	140,810,472	2,004,018	713,116	19,683,276
1910	38	1,294,282	a 587,476	a 1,208,274	145,310,623	1,176,416	.....	19,746,155
1911	44	1,167,237	783,981	1,946,319	132,290,007	6,907,388	22,423	18,663,891
1912	50	1,381,158	910,315	1,962,644	147,654,661	3,776,867	23,800	26,651,961
Increase (+) or decrease (−) in 1912	.....	+213,921	+126,334	+16,325	+15,364,654	−3,130,521	+1,377	+7,988,070

a Includes small placer production.

The output in Cochise County of 1,381,158 tons of ore in 1912 was made by 50 producers, 6 more than reported production in 1911, when 1,167,237 tons were mined. The total value of the metals from this ore was $26,651,961, against $18,663,891 in 1911, a gain of $7,988,070, attributable to the increase in the ore production and the higher price of copper. The total average value per ton increased from $15.99 in 1911 to $19.30 in 1912, but the gold and silver value of this ore decreased from $1.55 per ton in 1911 to $1.53 per ton in 1912. Gains were made in value of all the metals contained in the ores except lead. The gold output increased from $783,981 in 1911 to $910,315 in 1912; the silver yield, valued at $1,031,549 in 1911, increased to $1,207,026 in 1912; the copper production from $16,536,251 in 1911 to $24,363,019 in 1912; and the zinc output from $1,278 to $1,642. The value of the lead production decreased from $310,832 in 1911 to $169,959 in 1912. The copper ores of shipping grade treated at the

smelters aggregated 1,277,422 tons, and contained 38,142.04 ounces of gold, 1,392,239 ounces of silver, 145,248,790 pounds of copper, and 535 pounds of lead. Shipments of lead ore were made to El Paso aggregating 19,013 tons, containing 5,172.9 ounces of gold, 488,385 ounces of silver, 63,736 pounds of copper, and 3,740,596 pounds of lead. Of the copper ores produced, 488,310 tons were oxidized and 789,112 tons were sulphide ores. The larger part of the lead ore, aggregating 11,778 tons, was sulphide, and the oxidized ores amounted to 7,235 tons. One small shipment of oxidized zinc ore was made from Cochise district. No placer productions were reported.

California district.—Four producers shipped 230 tons of siliceous copper, copper-lead, and lead-sulphide ores of smelting grade. The total metallic content was $12 in gold, 2,568 ounces of silver, 12,688 pounds of copper, and 19,873 pounds of lead, valued in all at $4,578, or an average value of $19.90 per ton. The principal production came from the Homestake property, yielding a siliceous ore containing silver and some copper. Other properties producing were the Black Ben, Silver Hill, Humboldt, Hilltop, and Katherine claims.

Cochise or Johnson district.—The metallic production from 8 deep mines was produced principally from copper oxidized ore, containing $353 in gold, 22,826 ounces of silver, 604,581 pounds of copper, 121,380 pounds of lead, and 23,800 pounds of zinc, valued in all at $121,251, or an average value per ton of $30.49. Shipments of copper ore were made from the Mammoth & Republic, Keystone, Black Prince, Copper Bell, Peabody, and Texas-Arizona properties. The latter also yielded some oxidized zinc ore of commercial grade.

Dos Cabezos district.—Most of the ore mined in the district, that by three producers, was treated in an amalgamation mill, producing bullion containing gold and silver, and 66 tons were shipped directly to the smelters. The total output was valued at $10,135, or an average value per ton of $25.59. Oxidized and sulphide copper ores were produced from the Bachelder group, and some siliceous ores, carrying gold and a little lead and silver, were mined from the Henry Clay claim. The ore treated by amalgamation was from the Dives property.

Hartford or Huachuca district.—A number of small shipments of copper oxidized ores were made, aggregating 33 tons, with a total value of $1,409, and an average value per ton of $42.70.

Tombstone district.—Seven producers shipped 7,405 tons of ore, containing $28,177 in gold, 158,377 ounces of silver, 27,723 pounds of copper, and 617,820 pounds of lead, valued in all at $157,956, or an average value per ton of $21.33. The Tombstone Consolidated property was operated by lessees who shipped the larger part of the district production. Other shipments were made from the Hershell and some of the old surface workings.

Turquoise or Courtland district.—Reports from 12 producers gave an aggregate production of 130,709 tons of ore, containing $60,363 in gold, 250,667 ounces of silver, 8,282,308 pounds of copper, and 44,213 pounds of lead, valued in all at $1,583,094, or an average total value per ton of $12.11. The output in 1911 was 57,094 tons, which, with 3,991 tons of old tailings, had a value of $483,448, or an average value per ton of $7.91. The 1912 production included the shipment of 23,699 tons of old tailings from the Commonwealth

property. The largest production of sulphide copper ore came from the Copper Belle or Leonard mines. This ore is used as flux in the reduction works at the Shannon smelter near Clifton. The Mary and Mamie mines of the Great Western Mining Co. yielded oxidized and sulphide ores, the former in the greatest quantity, and also a small lot of oxidized lead ore. Most of this output was shipped to El Paso. The Germania mine[1] produced the next largest output of oxidized copper ores which was shipped to Douglas.

In order to take advantage of the profitable market for copper and supplement our diminishing reserve of oxide ores in Bisbee, our Courtland mines were reopened on the first day of July. * * * Shipments averaging 600 tons a week were started. * * * The amount of available ore left in the mine is approximately 23,000 tons that will average about 5 per cent copper.

Warren district.[2]—Eleven producers reported in 1912 a yield of 1,238,408 tons of ore, valued at $24,773,538, or an average value of $20 per ton, against a production of 1,095,895 tons of ore, valued at $17,918,545, with an average of $16.35 per ton, in 1911. The tonnage was next to the largest, but was the richest, of all districts in the State, and contained $814,677 in gold, 1,526,987 ounces of silver, 138,703,193 pounds of copper, and 2,971,923 pounds of lead. From 35 to 40 per cent of the copper ores produced are oxidized and the remainder are sulphide. New ore discoveries at depth and in territory adjacent to the older claims in what was formerly deemed barren ground are described by Douglas.[3]

A feature of interest in the Warren district was the finding of larger quantities than heretofore of primary sulphides in the limestones below the Carboniferous, even in the Cambrian. They do not constitute large bodies, and have been up to the present accidentally encountered. When their mode of occurrence is better understood they may constitute an important source of supply. A more noteworthy development was made in the exploration of feldspathic rocks, especially in the prominent mass which composes Sacramento Mountain. These rocks promise to add notably to the life of the district.

The tonnage extracted from the Copper Queen mines[4] in 1912 was the greatest in the history of the company, and through a more systematic method of underground sampling and sorting, the grade of the ore was maintained at approximately the same copper contents as in 1911. In view of the greater tonnage of ore extracted it was considered advisable to materially increase the exploration and development work in order to maintain the ore reserves in sight at a higher figure than it has been deemed necessary in the past. * * * Systematic development in the hitherto little explored porphyrys, both in underground methods and by surface drilling, has indicated a promising field of future exploration and has already added greatly to the ore reserves. * * * Shipments of lean sulphide to the Old Dominion Copper Mining & Smelting Co., at Globe, were continued in varying amounts. Gold, silver, and lead ores, carrying too little copper to be classed as copper ores, were mined, partly on company account and partly by leasers, and shipped to the smelter at El Paso of the American Smelting & Refining Co. * * * Of the 64,480 tons of slag shipped to Douglas, 32,539 tons came from the Czar dump, near the old smelter, and 31,941 tons from the lower dump, on the north side of the gulch.

The ore mined aggregated 786,368 tons, which included 116,969 tons of precipitates and old slag, smelter cleanings, and lease ore. From this tonnage there was produced 15,217 ounces of gold, 666,264 ounces of silver, and 84,086,261 pounds of copper. Included in the tonnage above were 11,626 tons of lead ore shipped to El Paso, containing 3,889 ounces of gold, 326,962 ounces of silver, 30,434 pounds of copper, and 2,953,685 pounds of lead.

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[1] Ann. Rept. Calumet & Arizona Mining Co. for year ending Dec. 31, 1912.
[2] Ransome, F. L., Geology and ore deposits of the Bisbee quadrangle, Arizona; Prof. Paper, U. S. Geol. Survey No. 21, 1904, 168 pp.
[3] Douglas, James, Eng. and Min. Journ., Jan. 11, 1913, p. 61.
[4] Ann. Rept. Phelps, Dodge & Co., for year ending Dec. 31, 1912.

From the Calumet & Arizona mine[1] 176,049 tons of copper ore and 18,471 tons of fluxing ore were smelted, yielding 16,490,229 pounds of copper, 233,072 ounces of silver, and 9,066 ounces of gold. The smelting ore yielded an average of 92.13 pounds of copper per ton, and the fluxing ore 15.3 pounds per ton. The regular ore as mined averaged 5.07 per cent of copper and the fluxing ore 1.06 per cent. The total amount of development work was 25,787 feet, compared with 26,196.5 feet in 1911. Dividends aggregating $2,542,781 were paid during 1912. During the latter part of 1912 it is reported that some important new deposits were opened on the 1,400 and 1,500 foot levels farther southwest from the Briggs shaft than any ore heretofore found. The company will concrete its Junction shaft from top to bottom. Water no longer bothers the management. At one time 6,000 gallons of water per minute were pumped from the Junction and Briggs shafts, and the old Superior & Pittsburg was often referred to as a water company rather than a mining company, but the water flow has been reduced to 3,000 gallons per minute and the richest ore in the district was found where the water came from.

From the Superior & Pittsburg property[1] 288,429 dry tons of ore were smelted, yielding refined bullion containing 361,227 ounces of silver and 13,815 ounces of gold. The largest part of 29,547 feet of development work was done through the Junction shaft. Dividends amounting to $1,919,738.76 were paid during 1912.

At the Shattuck-Arizona mine[2] 2,802 tons of ore were mined, yielding 1,253,305 pounds of copper, 21,008 ounces of silver, and 13 ounces of gold, as well as 1 car of lead carbonate ore.

The important development during the year, one of the most important since development started on the property, was the finding of good carbonate ore on the 400-foot level, and both above and below this level. Owing to their high-line contents these ores can be most advantageously mixed with the aluminous ores found between the 600-foot and 800-foot levels. * * * In addition to good copper values it has been found that between the 300-foot and 400-foot levels the ores carry better silver values than ores heretofore developed in the mine, the silver values averaging approximately one-half ounce in silver to every per cent of copper contained in the ore. The best silver values are obtained when the copper is found in the siliceous breccia which we are now developing above the 400-foot level. The high silica ores are an additional advantage, assuring the company of sufficient tonnage of material suited for converter lining at the reduction works when treating its own ores. * * * Between the 400-foot and 300-foot levels there is a good sized body of lead carbonate ore which gives promise of proving a valuable asset. The lead ore is similar in character to the lead ores found along the Czar Fault developments in Copper Queen territory adjoining us on the north, and some very large shipments have been made by the Copper Queen from its lead-bearing territory. * * * In the vicinity of the shaft, according to developments on the 800-foot level, there is much evidence of good sulphide ore bodies on the 900-foot level. * * * New plans are being prepared for a smelting plant, consisting of two blast furnaces, each of 400 tons daily capacity, and converting plant, to be erected at Douglas.

COCONINO COUNTY.

Two operators in the Francis district reported the production of oxidized copper ore, the total average value increasing from $4.46 to $9.54 per ton. There was very little gold and silver contained in the ore.

[1] Ann. Rept. for year ending Dec. 31, 1912.
[2] Ann. Rept. for year ending Aug. 1, 1912.

GILA COUNTY.

Number of producers, quantity of ore sold or treated in Gila County, Ariz., in 1905–1912, and content in gold, silver, copper, and lead.

County.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	10	241,328	$50,997	84,982	24,991,794	.....	$4,001,046
1906	14	415,471	47,916	122,098	28,492,391	.....	5,628,753
1907	42	444,860	[a] 62,039	[a] 94,062	36,875,993	161,523	7,507,880
1908	24	442,430	54,780	164,900	37,380,914	70,487	5,079,418
1909	23	445,688	[a] 25,408	[a] 155,493	39,451,896	13,442	5,235,588
1910	46	312,057	[a] 25,229	[a] 174,696	31,330,222	6,102	4,098,772
1911	44	735,432	[a] 50,310	[a] 247,813	49,226,341	10,466	6,335,415
1912	32	1,450,201	33,939	264,941	63,969,423	47,349	10,753,964
Increase (+) or decrease (−) in 1912	.....	+714,769	−16,371	+17,128	+14,743,082	+36,883	+4,418,549

[a] Includes small placer production.

In 1912 the production of ore from Gila County aggregated in value $10,753,964, an increase from the production of 1911 of $4,418,549. Altogether the ores mined yielded $33,939 in gold, a decrease of $16,371 compared with 1911; the silver yield increased in value from $131,341 to $162,939; the copper from $6,153,293 to $10,554,955; and the lead from $471 to $2,131. There were 32 producers in 1912, against 44 in 1911. The total value per ton of the ore decreased from $8.61 to $7.41 in 1912, and the value of gold and silver contained in this ore from 25 cents to 13 cents per ton. These decreases were caused mainly by the increased output of low-grade copper ores of concentrating grade, which increased from 585,408 tons in 1911, producing 66,303 tons of concentrate, to 1,210,366 tons, producing 91,810 tons of concentrate in 1912. The latter contained $14,170 in gold, 124,350 ounces of silver, and 40,755,232 pounds of copper, in all valued at $6,815,258, or an average value of $74.23 per ton. The ore of smelting grade aggregated 180,871 tons, the larger part of which, or 168,916 tons, was oxidized copper ore and 11,687 tons of which were sulphide copper ore. There were also small tonnages of dry or siliceous ore and lead ore produced. The smelting ores were valued at $3,551,125, or an average value of $19.63 per ton. A small quantity of lead ore produced in the vicinity of Globe was shipped to the El Paso, Tex., smelter. From the old slag dumps of the Old Dominion and the United Globe properties slag was re-treated and yielded over 2,000,000 pounds of copper.

Banner district.—Two properties produced 1,016 tons of ore, averaging in value $26.71 per ton for the gold, silver, and copper content. All of this tonnage was oxidized copper ore shipped to the Hayden smelter.

Globe district.[1]—The production of the district forms the largest part of the output of Gila County, and aggregated 1,449,013 tons in 1912, against 735,345 tons in 1911. Concentrating ore aggregated 1,210,366 tons, and yielded 91,810 tons of concentrates, which contained 685.46 ounces of gold, 124,350 ounces of silver, and 40,755,232

[1] Ransome, F. L., The Globe copper district, Arizona: Prof. Paper U. S. Geol. Survey No. 12, 1904, 168 pp.

pounds of copper. The ore of smelting grade aggregated 179,711 tons and contained 933.07 ounces of gold, 135,061 ounces of silver, 20,656,948 pounds of copper, and 47,349 pounds of lead. In addition to this there were 58,836 tons of old slag re-treated.

Ore from the Old Dominion mine[1] yielded 16,533,999 pounds of fine copper, 42,751 ounces of silver, and 583 ounces of gold. There were milled 106,232 tons of ore which assayed 3.15 per cent of copper, as compared with 3.5 per cent of copper in 1911. The smelting ore aggregated 93,592 tons of 6.43 per cent grade, as compared with 96,187 tons of ore assaying 7.75 per cent of copper in 1911. Dividends amounting to $567,000 were paid in 1912, making a total of $2,551,500 since July 18, 1907.

During the year lessees mined 5,191 tons of mostly iron ore from the levels above the second level, and from the Old Dominion Keystone there were 644 tons extracted by lessees. * * * During the year there was pumped from the mine 1,441.48 million gallons of water, compared with 1,277.02 million gallons in 1911. * * * The average flow of water in the mine during 1912 was 3,938,474 gallons per 24 hours, or about 439,549 gallons per day higher than the previous year. About one-half of this still comes from the Dacite on the twelfth level west, the remainder from the fourteenth and sixteenth levels. The strong flow struck in the limestone on the sixteenth level east has diminished gradually, being for December 670,000 gallons per 24 hours. The rate of flow in the mine varied from a minimum of less than 3,500,000 gallons in April and December to a maximum of 5,000,000 gallons per day in August. * * * During the latter part of the year it was found profitable to ship to the smelter for re-treatment slag from the old slag dump in the creek, and nearly 3,500 tons were shipped. There is probably that much more that can be handled at a good profit during the coming year.

The United Globe property[1] produced 132,076 tons of ore and 55,357 tons of old slag in 1912, compared with 98,023 tons of ore and 12,475 tons of slag in 1911. The oxidized copper ore averaged 6.12 per cent of copper, the sulphide 1.91 per cent of copper, the concentrating ore 2.63 per cent of copper, and the silica converter lining 4.25 per cent of copper. The average assay of the slag was 1.95 per cent of copper. Shipments were made to the Old Dominion, Copper Queen, El Paso, Hayden, and Cananea smelters. Dividends were paid from 1905 to 1912, amounting to $839,500 and in 1912 the dividends amounted to $345,000.

The greater part of the exploration and development work has been done on the Old Dominion vein. The vein has now been opened up from the west end of the property on the tenth, twelfth, and fourteenth levels. The sixteenth level East has been pushed 280 feet over the line, the vein crosscutted in three places, and a raise put through to the fourteenth level. It would be conservative to say that in these three crosscuts the vein shows to be on an average of 15 to 20 feet wide and assays between 4 per cent and 5 per cent copper. * * * During this year, as in the previous, stoping has been carried on on the Old Dominion vein from the sixth to the fourteenth levels, the Gladiator claim having produced 56,132 tons and the Hoosier claim 21,269 tons, including siliceous ores shipped to various smelters in the Southwest, to be used for converter lining. The Maggie and Josh Billings veins have produced 8,684 tons of low-grade sulphide and the Grey No. 3 vein 1,000 tons of the same class of ore. Considerable concentrating ore has also been shipped from the Grey mine. The flow of water in the sixteenth level, East Drift, has diminished considerably of late and does not now exceed 700,000 gallons in the 24 hours.

Concentrating ore aggregating 1,040,744 tons mined from the Miami Copper mine[2] contained 46,683 tons of concentrate, from which 32,832,609 pounds of copper were recovered in 1912.

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[1] Ann. Rept. Old Dominion Copper Mining & Smelting Co. for year ending Dec. 31, 1912.
[2] Ann. Rept. for year ending Dec. 31, 1912.

The development work for the year consisted in the completion of the 420-foot extraction level and the sublevels and raises in the Northwest ore body. * * * Considerable full-sized drifting was done on the 570-foot level, so as to prepare it for a main extraction level. A station was cut at the 720-foot level at No. 4 shaft, but as it will be several years before the ore tributary to this level is needed, the work of driving the crosscut has not yet been started. * * * The sixth and last section was started about the last of February and during the year the average section product per day was 489 tons of ore. During certain periods, depending on the character of the ore, this has been greatly exceeded, at times being 524 tons per section per day. Our ore is very hard to crush and the rigid rolls used for the intermediate crushing were partially replaced during the year by a special heavy type of spring roll, and the Chilean mills by Hardinge pebble mills. This change was completed in the early part of 1913, and will result in a considerable decrease in the cost of crushing. * * * The results of milling operations for the year are as follows:

Operation of Miami copper mine, Arizona, in 1912.

	Quantity.	Average of copper.
		Per cent.
Ore milled.....tons..	1,040,744	2.39
Concentrate produced.....do....	46,683	37.02
Copper in concentrate.....pounds..	34,560,665	.....
Copper recovered per ton ore.....do....	33.21	.....
Mill extraction.....per cent..	69.39	.....

From the above concentrate produced, the net smelter returns of refined copper amounted to 32,832,609 pounds. Based on the smelter returns, the cost of refined copper in concentrate on board cars at Miami was as follows:

Cost of copper in concentrate f. o. b. cars at Miami, Ariz., in 1912.

	Per ton ore.	Per pound of copper.
Mining.....	$1.20315	$0.03813
Milling.....	.65861	.02087
General.....	.18023	.00577
Total.....	2.04199	.06477

* * * During the year 21 churn drill holes were put down from surface to an average depth of 612 feet. * * * Part of these drill holes encountered high-grade ore and part of them demonstrated the existence of a belt of 1.2 per cent copper material 500 feet in width lying to the north of the Northwest ore body. While this material is not classed as ore, its copper, together with its pyrite contents, may some day make it of value. * * * On January 1, 1913, the ore reserves were estimated to amount to 20,800,000 tons * * * and a new combining of all available figures indicates the average assay of the above reserve to be about 2.48 per cent copper.

The Inspiration mine[1] yielded in 1912 a small quantity of ore, which presumably was taken from the old dumps or resulted from tests on the low-grade ore.

The underground work of 1912, which was practically done during the last half of the year, was preparatory to ore extraction within the ore areas developed by the churn drills and was not designed to be exploratory in character; therefore the work has not resulted in any additions to the estimate based on the churn drilling at the time of the consolidation, which was 45,000,000 tons of 2 per cent ore. * * * No suitable mill site was available near the main shafts, but a very satisfactory one has been acquired about 1½ miles below the main shafts, together with ample and convenient ground for tailings storage. Plans have been made for a concentrator of 7,500 tons daily capacity. * * * In December last the company arranged with

[1] Ann. Rept. Inspiration Consolidated Copper Co. for year ending Dec. 31, 1912.

the Minerals Separation Co. to make a trial of its flotation process, a method by which in a mixture of one part by weight of finely crushed ore and from two to three parts of water the mineral constituents are separated from the waste and floated to the surface, there forming a froth to be skimmed off, such separation and flotation being accomplished by the introduction into the pulp of a small quantity of certain oils, accompanied by the aeration of the pulp by violent stirring previous to the flotation. A machine of 50 tons daily capacity has been sent to the mines and tests are now being made, from the results of which will be determined whether or not this process will be adapted to the treatment of our ores.

Small productions were made from the Green Valley, Lost Gulch, Pine, and Pinto districts.

GRAHAM COUNTY.

Three producers reported the production of 83 tons of ore, part of which was milled, producing gold and silver bullion, and the remainder of which was lead and copper ore shipped directly to the smelters.

Arivaipa district.—The Rattlesnake property was a producer of a small tonnage of lead ore shipped to the smelter. There was also some ore yielding gold and silver bullion treated in an arrastra on the property.

Lone Star district.—In doing location work, about 2 tons of ore were produced from the Carlos claim, containing 4 ounces of silver per ton and 14 per cent of copper.

Pinaleno Range district.—This district is situated about 11 miles in a northerly direction from Glade, a station on the Southern Pacific Railroad. A small test lot of oxidized copper ore, containing silver, was shipped.

GREENLEE COUNTY.

Number of producers, quantity of ore sold or treated in Greenlee County, Ariz., in 1905–1912, and content in gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	
1905	[a] 9	952,509	$46,222	57,191	53,939,212	800,000	$8,532,882
1906	[a] 18	1,259,161	55,809	130,904	59,270,459	221,600	11,595,345
1907	[a] 35	1,418,499	[b] 30,513	[b] 87,578	62,720,962	14,142	12,633,256
1908	[a] 30	1,508,287	[b] 28,703	[b] 124,531	77,149,079	30,255	10,279,653
1909	[a] 25	1,566,989	[b] 38,682	[b] 88,082	71,826,650	44,729	9,423,873
1910	23	1,561,167	[b] 48,191	[b] 147,060	72,878,094	31,576	9,384,511
1911	23	1,551,220	31,541	104,429	70,926,330	30,734	8,954,062
1912	27	1,746,905	36,220	77,743	76,848,299	.....	12,764,001
Increase (+) or decrease (−) in 1912	.....	+195,685	+4,679	−26,686	+5,921,969	−30,734	+3,809,939

[a] Includes small district production Graham County.
[b] Includes small placer production.

Twenty-seven producers in Greenlee County reported in 1912 the production of 1,746,905 tons of ore, which is 195,685 tons more than was mined by 23 producers in 1911. The total average value of the ore increased from $5.77 to $7.31 per ton. Copper ores from the Shannon mines and siliceous custom ores used for converter lining produce most of the gold and silver. The total average of the district is very small, since the recovery of these metals is not reported by the

other companies. The larger part of the ore produced is of concentrating grade, and in 1912 aggregated 1,511,093 tons, yielding 212,898 tons of copper concentrate, which contained $10,379 in gold, 14,244 ounces of silver, and 58,539,890 pounds of copper, valued in all at $9,678,221, or an average value per ton of $45.46. The crude ore directly smelted aggregated 216,591 tons and contained $25,514 in gold, 63,492 ounces of silver, and 17,752,749 pounds of copper, valued in all at $2,993,766, or an average value per ton of $13.82. The larger part of the smelting ores was oxidized copper ores, of which 186,785 tons were produced in 1912, and of the remainder 25,865 tons were sulphide copper ore, and 3,941 tons were siliceous ore. From 19,131 tons of old slag 555,660 pounds of copper were produced.

The production of the county comprises the output of the Copper Mountain and Greenlee districts,[1] the latter producing 1,222,101 tons, valued at $8,602,414, of the total county production, or an average of $7.04 per ton. The Copper Mountain district produced 524,695 tons, valued at $4,157,177, or an average value of $7.92 per ton.

The Arizona Copper Co.[2] mines yielded 38,132,000 pounds of bessemer copper, as compared with 34,569,019 pounds in 1911. This is the largest production since the company began operations.

The total ores mined from the company's properties during the year amounted to 927,116 dry tons, and the yield, as indicated by the smelter returns, averaged 41.15 pounds of copper per ton of ore, a decrease of over 5 pounds per ton as compared with the previous year. Of the total ores produced by the mines, 655,396 tons, or about 70 per cent, came from the Longfellow group and 271,720 tons, or 30 per cent, came from the Metcalf group. About 96 per cent of the ores mined were concentrating ores, the remaining 4 per cent being direct smelting ores (including pyrites for acid plant and siliceous ores for converter lining). Of the total copper produced, 84½ per cent came from sulphide ores and 15½ per cent from oxide ores. * * * During the year 782,100 dry tons of sulphide concentrating ores were treated, of which 547,565 tons, or 70 per cent, were treated at No. 6 concentrator, and 234,535 tons, or 30 per cent, were treated at the Clifton concentrator. * * * During the year the oxide concentrator treated 108,230 dry tons of ore, tailings from which, amounting to 89,890 dry tons, were treated in the leacher. From these ores 9.71 per cent of our total copper productionwas obtained. The sulphuric acid plant supplied the leacher with 3,998 tons of acid. * * * During the year an average of 3.24 furnaces were in blast, and the total ore and concentrates smelted amounted to 158,529 tons; with fluxes and by-products smelted, the amount was 236,035 tons. The average yield of copper from ores and concentrates was 12.03 per cent. The elimination of siliceous matter from the concentrates by the operation of the redressing plants reduced the amount of flux required to a notable extent, thereby increasing the capacity of the furnaces and effecting an important economy in the cost of smelting.

The Detroit copper mines[3] yielded 520,272 tons of smelting and concentrating ore, which produced 24,802,789 pounds of copper, or an average of 47.67 pounds per ton. The larger part of the ore, aggregating 501,451 tons and assaying 3.08 per cent of copper, was concentrated (7.1:1), producing 70,438 tons of concentrate, assaying 16.69 per cent of copper, which represented a mill saving of 76.12 per cent.

The Shannon mines[4] and smelter produced 16,406,336 pounds of copper, 2,615.02 ounces of gold, and 170,690 ounces of silver. A small

[1] Lindgren, W., The copper deposits of the Clifton-Morenci district, Arizona: Prof. Paper U. S. Geol. Survey No. 43, 1905, 375 pp.
[2] Ann. Rept. for year ending Sept. 30, 1912.
[3] Ann. Rept. Phelps, Dodge & Co., for year ending Dec. 31, 1912.
[4] Ann. Rept. Shannon Copper Co. for year ending Aug. 31, 1912.

tonnage of custom ores were treated to provide desirable fluxing material not found on the company's own property.

During the year 1911–12 we extracted from the Shannon Copper Co.'s mines at Metcalf 285,210 tons of ore, of which 42,125 tons came from open cuts, 216,183 tons from the intermediate levels, 26,006 tons from what is known as the Carter (or lower) level, and 897 tons from developments on outside claims. The grade of ores obtained from the lower levels, while not as high as we anticipated, is much better than the average of the mines. This is a factor which will have an important bearing on the future of the mines.

Mayflower district.—Copper and siliceous ores were shipped from the district and aggregated 109 tons, valued at $4,410, or an average value of $40.46 per ton.

MARICOPA COUNTY.

An increase of 867 tons brought the total production of ore mined to 20,123 tons in 1912. The total average value of this ore increased from $5.05 to $16.48, and the gold and silver value from $5.05 to $15.66 per ton. There was an increase in the number of operators of deep mines producing from 4 in 1911 to 9 in 1912. The greater part of the ore was of milling grade, producing bullion and precipitates from amalgamation and cyanide operations. The remainder was 427 tons shipped directly to the smelters. In all, the total value aggregated $333,072, an increase of $234,803 over the production of 1911. Five placer productions reported, which aggregated $1,349 in gold and 11 ounces of silver.

Cave Creek district.—Six producers, two of which were placers, yielded ore and bullion valued at $1,423. The ores aggregated 45 tons and contained $538 in gold, 27 ounces of silver, and 2,146 pounds of copper, all of which was shipped directly to the smelters.

Eagle Tail Mountain district.—The Santa Rosa property, situated 30 miles from Arlington, was reported as a producer of placer gold taken out during assessment work.

Magazine district.—This district situated 24 miles north of Cave Creek, produced an important output of copper ore, carrying gold and silver, which was shipped to Douglas and El Paso in 1912.

San Domingo district.—A very much smaller quantity of gold was taken out from the dry placers in this district than heretofore, presumably on account of most of the ground being controlled by a company proposing to operate the placers on a larger scale.

Vulture district.—The largest producer was the Vulture mine, from which was produced an important tonnage of ore, treated in a 20-stamp amalgamation, concentration, and cyanidation mill. The concentration plant was added in 1912, and sulphide concentrates, rich in gold and silver, and with some copper and lead, were shipped. The process of treatment consists of stamping in cyanide solution, regrinding, and continuous decantation. A 75-pound spring stamp mill, with a 2-horsepower engine, was operated on the Finance group, and a small quantity of gold bullion was produced.

MOHAVE COUNTY.

Number of producers, quantity of ore sold or treated in Mohave County, Ariz., in 1904–1912, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	13	47,520	$563,824	86,782	1,420	6,036	.....	$613,956
1905	21	52,712	543,090	73,536	30,399	112,266	.....	597,525
1906	27	64,832	641,034	145,179	315,992	904,399	.....	850,841
1907	49	68,887	585,383	80,897	601,210	1,229,654	.....	825,997
1908	42	76,708	295,736	39,427	345,491	254,013	505,133	396,646
1909	30	30,822	[a] 356,363	[a] 79,662	313,384	113,406	5,264,121	727,666
1910	40	99,283	1,145,022	112,445	529,753	740,091	5,474,046	1,601,183
1911	47	140,402	1,547,663	143,969	244,378	2,591,589	4,476,552	2,026,300
1912	40	202,937	[a] 1,899,131	[a] 174,343	644,145	1,937,031	8,304,462	2,772,810
Increase (+) or decrease (−) in 1912	.....	+62,535	+351,468	+30,374	+399,767	−654,558	+3,827,910	+746,510

[a] Includes small placer production.

With a production of 202,937 tons of ore by 39 deep-mine operators, the output of Mohave County increased 62,535 tons over that produced by 47 operators in 1911. The total average value per ton of the ore decreased from $14.43 in 1911 to $13.66 in 1912, and the gold and silver value in this ore from $11.57 to $9.89 per ton. The total value of the ore produced and the output of one placer in 1912 amounted to $2,772,810, representing $1,899,131 in gold, $107,221 in silver, $106,284 in copper, $87,166 in lead, and $573,008 in zinc. The output of 1912, compared with that of 1911, showed an increase in tonnage and in all the metals except lead, and an increase of $746,510 in total value. Of the total tonnage, the greater part, or 165,187 tons, was treated in gold and silver mills, yielding $1,805,329 in gold and 41,638 ounces of silver. Nearly all the bullion was won by the cyanide process. The concentrating ores, aggregating 21,719 tons, yielded 9,819 tons of concentrates of lead and zinc, containing $56,904 in gold, 79,072 ounces of silver, 125,688 pounds of copper, 1,523,888 pounds of lead, and 5,560,824 pounds of zinc, valued in all at $578,544, or an average value per ton of $58.92. The crude ores shipped to smelters, aggregating 5,869 tons, consisted of 137 tons of siliceous ore, 1,190 tons of copper ore, the larger part of which was oxidized; 511 tons of lead ore, nearly all of which was sulphide; and 4,031 tons of sulphide zinc ore. Part of the lead-zinc ore was treated at the concentration plant connected with the Needles smelter, where a wet mill and an electrostatic zinc separating plant are in use. The zinc ores of shipping grade and concentrates were shipped to zinc plants outside of the State. The geology and mineral deposits are described in a bulletin published by the Survey.[1]

Aubrey district.—The Doyle property produced a small quantity of mill bullion from the treatment of ore in the 1-ton prospecting mill.

Bentley district.—In 1912 the Grand Gulch mine was the only producer in this district. The shipments consisted of 1,152 tons of oxidized copper ores, which are now hauled on motor trucks to St.

[1] Schrader, F. C., The mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: Bull. U. S. Geol. Survey, No. 397, 1909, 226 pp.

Thomas and shipped over the branch road from St. Thomas to Moapa and thence to Salt Lake.

Cedar Valley district.—A small lot of ore from the Hoffman property, containing gold and silver, was produced in 1912.

Cottonwood district.—The ore of the Walkover property was treated in an arrastre, and an important tonnage of siliceous ore was shipped to the smelter, containing a small quantity of lead and high values in gold and a little silver.

Gold Basin district.—Two producers reported the production of 260 tons of ore, part of which was treated in a cyanide mill and some of which was shipped directly to the smelter.

Greenwood district.—One producer reported the production of gold bullion extracted from ore treated in an arrastre.

Maynard district.—The Holy Moses claim produced siliceous gold ore, containing small values in silver, which was treated by the amalgamation process in a 3-stamp mill on the property.

Owens district.—The Sapphire Co. shipped copper sulphide ore containing gold. There was small production from three other adjoining properties.

San Francisco district.—Three mines in 1912 produced 174,319 tons of ore, yielding $1,794,847 in gold and 41,456 ounces of silver, valued at $1,820,342, or an average value per ton of $10.44. The entire product was treated at milling plants equipped with the cyanide process, and bullion and cyanide precipitates, containing gold and silver, were produced. The largest producers were the Tom Reed and the Gold Road mines.

There was produced and milled at the Tom Reed mine[1] 43,478 tons of ore and 12,185 tons of tailings, from which gold and silver bullion valued at $1,154,558.87 was recovered by the cyanide process, thus exceeding the record of 1911. The bulk of the ore treated in 1912 was mined between the 350-foot and the 550-foot levels. Dividends totaling $563,924.10 were paid during the company's fiscal year, making in all a total of $1,155,220 which has been paid to stockholders.

The Gold Road mine[2] produced in 1912 a siliceous gold ore, of which 109,070 tons were extracted and sent to the mill.

The development yielded as much ore as could be expected, but the grade was disappointing. Exploration work is going on with undiminished vigor, and it is expected that in the large territory still to be opened up better values will be encountered. The mill was improved and enlarged and now handles 350 tons per day as against 225 tons a year ago. The development work in this mine included the extension of the 350-foot, 500-foot, and 700-foot levels, the sinking of what is known as the No. 3 shaft from the 700-foot to the 900-foot level and some drifting on the 900-foot level on the vein.

Wallapai district.—Included in this district is the production of the mine at Union Basin. The largest producers were the Golconda, Banner, and Tennessee mines. The total output aggregated 26,528 tons, which contained $94,843 in gold, 131,222 ounces of silver, 209,100 pounds of copper, 1,936,760 pounds of lead, and 8,304,462 pounds of zinc, valued in all at $870,209, or an average value per ton of $32.80. The Golconda mine was worked by the Union Basin Mining Co., which shipped crude zinc ore and zinc concentrates mixed to Bartlesville, Okla., and lead concentrates to El Paso.

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[1] Ann. Rept. for year ending Apr. 1, 1913.
[2] Ann. Rept. United States Smelting & Refining Co. for year ending Dec. 31, 1912.

The Needles [1] (California) smelter and concentrator were operated at intervals, principally on ores from the mines of the Needles Mining & Smelting Co., situated in this district.

The supply of ore that was expected to come from the Tennessee mine did not materialize on account of the failure of the railroad company to complete a spur to the mine. This track is now completed, and ore from the Tennessee mine is being shipped and the mill has been started. The shaft of the Tennessee mine was during the year sunk to the 900-foot level, and a crosscut is now being run to cut the vein on that level. It is confidently expected that the ore will be as strong on the 900-foot level as it is on the 700-foot level. Three winzes were sunk in the ore from the 700-foot level to a depth of 30 feet, and the ore showed undiminished size and value to that depth. At the Banner mine work was discontinued during the year, when the small ore body was exhausted.

Ore was also produced from the Midnight, Rainbow, Hercules, Badger, Dixie Queen, Lochiel, and Rico properties.

Weaver district.—The Kemple and the Mocking Bird properties were operated during part of 1912. Ore was mined from the Kemple property and treated in the 5-stamp amalgamation and concentration mill, producing only bullion. Some ores were cyanided from the Mocking Bird property.

PIMA COUNTY.

The building of the railroad between Tucson and Nogales and the erection of the copper matting plant at Corwin caused many operators to take advantage of the situation to ship and test small quantities of ore. The total output of the county was valued at $395,382, an increase of $258,206 over the production of 1911. The total output for 1912 includes $4,997 in gold from deep mines and $4,461 in gold from placers, 41,956 ounces of silver, 2,112,837 pounds of copper, 84,296 pounds of lead, and 111,737 pounds of zinc. The number of deep mine producers increased from 19 in 1911 to 53 in 1912, and the ore output from 8,210 tons to 29,651 tons. The total average value of the ore produced decreased from $16.24 in 1911 to $13.18 in 1912, and the gold and silver value in this ore from $1.12 to $1.04 per ton. The larger part of the production, or 21,970 tons, was oxidized copper ore treated at smelters in the State, mainly at the Pioneer smelter at Corwin, near Tucson, but also at El Paso, Tex. The smelting ore contained $1,988 in gold, 41,089 ounces of silver, 1,961,043 pounds of copper, and 84,296 pounds of lead, and included zinc ore containing 111,737 pounds of zinc. The smelting ore had a total value of $362,333 and an average value per ton of $15.33. Old tailings treated by cyanidation yielded gold valued at $2,709 and 66 ounces of silver, and 3,820 tons of ore concentrated produced 191 tons of copper concentrates containing gold, silver, and copper valued at $25,815, or an average value per ton of $135.16.

Ajo district.—Ore treated at the 10-stamp mill of the Ajo mine produced copper concentrates. These, with sulphide ores, were shipped to Douglas. The ore carried small values in gold and silver.

Amole district.—Four properties produced 522 tons of copper ore, most of which was sulphide, shipped to the Pioneer smelter, and contained $7 in gold, 402 ounces of silver, and 21,437 pounds of copper, averaging in value $7.26 per ton.

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[1] Ann. Rept. United States Smelting & Refining Co. for year ended Dec. 31, 1912.

Arivaca district.—Five producers reported the shipment of 16 tons of ore and the treatment of 2,200 tons of tailings producing bullion. The total value of the output was $3,629.

Baboquivari district.—There were shipped from the Gold Bullion, Papago Chief, and Babasierra properties 67 tons of ore, carrying silver and small amounts of copper and gold. The total output averaged in value $74.95 per ton.

Empire district.—The largest production, consisting of oxidized copper ore, was made from the Total Wreck property. A small quantity of ore of the same character was shipped from the Montano and Matchless claims.

Greaterville district.[1]—There was very little new work done during 1912. The production from transient operators aggregated $3,557 in gold and silver, most of which was taken out by the use of rockers and dry washers.

Helvetia district.—The starting of the Pioneer smelter in 1912 gave new life to some of the mines in this district. During the year 467 tons of ore, principally copper sulphide, with small gold and silver values, were shipped with a total value of $6,353 and an average value of $13.60 per ton.

Pima district.—The yield of 22,197 tons of ore was reported by 27 producers in 1912. It contained $1,155 in gold, 34,475 ounces of silver, 1,787,971 pounds of copper, 56,199 pounds of lead, and 111,737 pounds of zinc, and had a total value of $327,611, and an average value of $14.76 per ton. Most of the copper ore was treated at the Pioneer smelter at Corwin, and some of it was shipped to El Paso and Douglas. The zinc ore went to eastern plants. The Twin Buttes and Plumed Knight properties, which were controlled by the smelter interests, were the largest producers. The zinc ore was produced from the Twin Buttes group by lessees. Copper-lead sulphide ore was mined from the Esperanza property.

PINAL COUNTY.

The ore produced by 15 deep-mine producers and the placer bullion output of one producer aggregated in value $6,228,252 in 1912. There were mined 1,577,211 tons of ore, containing $8,453 in gold, 111,896 ounces of silver, 37,261,241 pounds of copper, and 46,300 pounds of lead. The larger part of the tonnage, or 1,571,900 tons, was treated at concentration mills, yielding 95,236 tons of concentrates, valued at $5,976,546, or an average value per ton of $62.75. The principal part of this value was that of copper, with small values in gold and silver. The smelting ores aggregated 3,711 tons and had a value of $246,985, or an average value per ton of $66.55. The larger part of the ore, 3,437 tons, shipped to the smelters was copper sulphide ores, and of the remainder, 214 tons, was oxidized copper ore. The lead ore, 31 tons, was sulphide in character. The siliceous ores, aggregating 1,600 tons, were treated at amalgamation mills. Placer bullion amounting to $789 in gold and 6 ounces of silver was produced in the Old Hat district.

Bunker Hill district.—The output of a group of claims belonging to the Calumet & Copper Creek Mining Co. in this district yielded

[1] Hill, J. M., Notes on the placer deposits of Greaterville, Ariz.: Bull. U. S. Geol. Survey No. 430, 1910, pp. 11-22.

copper, silver, and a little gold, after being concentrated. There was also a small tonnage of ore of shipping grade produced. The mill is of 250 tons capacity at the present time, and is equipped with crusher and rolls and wet concentration over Wilfley, Card, and Isabel tables and Johnson vanners. Most of the ore used was from the Old Reliable claim, and other ore came from the Cumberland, American Eagle, and Silver Reef claims. Motor trucks have hauled the ore from the mine to the mill, but are being replaced by a 2-mile, 30-inch gauge railroad.

Butte district.—This district, near Florence, had one producer of oxidized copper ore, containing a little silver, taken from the surface workings of the Copper Belle claim.

Casa Grande district.—Two small shipments of ore, containing copper, silver, and a small amount of gold, were made from this district to the smelter.

Mineral Creek or Ray district.—The principal part of the district output of 1,565,876 tons of ore was from the Ray mine. All of this ore, with the exception of a small tonnage shipped direct to smelters, was concentrated at the 8,000-ton mill at Hayden.

During 1912 the Ray mines[1] produced a daily average of 4,278 tons of ore as against 2,478 tons during the operating months of 1911.

The total tonnage of ore mined from the beginning of operations up to the end of 1912 was 2,247,395 tons averaging 1.72 per cent copper; the total known tonnage remaining in the developed area is accordingly 80,656,973 tons averaging 2.2 per cent copper. The total area developed and included in tonnage calculations is 205.2 acres. * * * The total amount of underground development for the year in main laterals, drifts, shafts, and raises amounted to 133,345 feet, bringing the total since the beginning of operations up to 292,243 feet, or nearly 55½ miles. * * * During the year the American Smelting & Refining Co. completed its smelting plant, or at least sufficient of it to accommodate our present output, and it has been in continuous operation since May, having commenced to receive our entire output of concentrates in February. * * * The total ore treated during the year was 1,565,875 tons, as compared to 681,519 tons for the nine months of the year 1911, during which the mill was running. The increase of this year over last year was 884,355 tons, or approximately 130 per cent. * * * The average copper content of the ore treated was 1.677 per cent, as compared with 1.83 per cent for the year 1911. The average recovery for the year based upon the total copper contained in concentrates produced was 68.2783 per cent, corresponding to a recovery of 22.9 pounds of copper per ton of ore. The average recovery for the year 1911 was 63.01 per cent. The cost of milling was 46.878 cents per ton as compared with 59.45 cents for the previous year. * * * The total production during the year of copper contained in concentrates was 35,861,496 pounds as compared to 15,721,520 pounds for the nine months of the previous year, indicating again an increase of nearly 130 per cent. The average grade of concentrates produced was 18.944 per cent copper as compared to 22.044 per cent for the year 1911.

Mineral Hill district.—Small shipments of ore from two properties were made from the district.

Old Hat district.—One deep mine producer and 1 placer operator reported production. The latter covered the operations of the Mexican placer workers in the district. The entire output from deep mine and placer aggregated $8,869 in 1912.

Pioneer and Silver King districts.—Following the success of the Magma Copper Co. in opening a large body of sulphide copper ore in its Blackfoot and Silver Queen claims, prospecting on other claims was continued by some of the older copper companies. Among these was the Calumet & Arizona Co.[2] which optioned the Daggs-Newman

[1] Ann. Rept. for year ending Dec. 31, 1912.
[2] Ann. Rept. Calumet & Arizona Copper Co. for year ending Dec. 31, 1912.

group of 63 claims and 26 outlying claims. Work was started in the sinking of a 3-compartment shaft and in driving a tunnel. The shaft will be sunk to a probable depth of 600 feet, the anticipated ore horizon. On the Magma property the development consists of an adit 550 feet long and an 800-foot vertical shaft. An important tonnage of copper sulphides was shipped, assaying as high as 25 per cent of copper, and 25 ounces of silver and $2 in gold per ton.

SANTA CRUZ COUNTY.

In 1912 the production aggregated 14,282 tons of ore mined by 30 operators, which is 13,204 tons more than was mined by 17 producers in 1911. The total average value per ton decreased from $30.89 in 1911 to $27.68 in 1912, and the gold and silver value from $7.72 to $5.04 per ton. The total value of the ore produced was $395,391. This value was for $31,943 in gold, 65,104 ounces of silver, valued at $40,039; 1,922,102 pounds of copper, valued at $317,147; 100,004 pounds of lead, valued at $4,500; and 25,539 pounds of zinc, valued at $1,762. The larger part of the ore mined was shipped directly to smelters and aggregated 12,750 tons, containing $24,388 in gold, 56,228 ounces of silver, 1,908,787 pounds of copper, 96,121 pounds of lead, and 25,539 pounds of zinc, valued in all at $380,005, or an average value per ton of $29.80. Of the ore shipped to the smelter, the greater part, or 10,665 tons, was copper sulphide, and the remainder was oxidized. In concentration mills 1,532 tons of ore were treated, yielding 226 tons of concentrates, having a total value of $15,386, or an average value per ton of $68.08. There were no placer productions reported.

Harshaw district.—Only a small tonnage of copper sulphide ore and copper-lead oxidized ore was shipped, aggregating $9,751 in total value, or an average value of $135.43 per ton.

Nogales district.—One operator reported the production of siliceous ore.

Oro Blanco district.—The Austerlitz and Oro properties were operated, each producing sulphide ore containing copper and a little lead, with considerable values in gold and silver. Of the 2,951 tons of ore produced, 1,532 tons were treated at a concentration mill and the remainder was shipped with the copper concentrates to the smelters.

Palmetto district.—This district was given new life by the opening of the Three R property, which produced an important quantity of copper sulphide ore containing small values in silver and a little gold. All of the ore mined by 4 producers was shipped directly to the smelters and was valued at $259,436.

Patagonia district.—Twelve producers reported the output of 1,957 tons of ore, all of which was shipped directly to the smelters and contained $840 in gold, 6,302 ounces of silver, 266,984 pounds of copper, and 20,912 pounds of lead, valued in all at $49,710, or an average value per ton of $25.40. Most of the ore production was mined from the Morning Glory and Bonanza properties, and the larger part of the ores shipped were sulphides.

Tyndall district.—The ores produced in 1912 were principally sulphides and of shipping grade from 4 properties, and consisted of copper, copper-lead, lead, and lead-zinc ore. The latter was shipped

to Colorado. The largest producers were the Royal Blue mine and the Sheehy group.

Wrightson district.—Five producers shipped 165 tons of siliceous ore, copper sulphide, and lead sulphide ore to the smelters, containing $61 in gold, 2,922 ounces of silver, 21,487 pounds of copper, and 9,091 pounds of lead, with a total value of $5,812, and averaging in value per ton $35.22. Shipments were made from the Augusta, Blue Lead, Eldorado, Ivanhoe, and American Boy properties.

YAVAPAI COUNTY.

Number of producers, quantity of ore sold or treated in Yavapai County, Ariz., in 1904–1912, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	34	439,622	$2,013,747	953,622	30,826,286	497,905	.....	$6,436,105
1905	39	364,697	1,391,070	786,707	34,279,734	697,806	.....	7,259,097
1906	46	396,788	1,256,623	708,439	42,080,740	729,787	.....	9,894,458
1907	117	375,398	1,144,102	647,488	35,734,416	521,307	140,786	8,754,263
1908	79	314,113	1,116,793	602,645	36,248,440	362,334	.....	6,236,207
1909	56	323,489	952,243	578,580	37,125,964	409,890	.....	6,097,105
1910	104	417,308	881,970	669,702	40,824,556	264,911	.....	6,456,184
1911	109	245,165	689,684	764,744	36,103,649	318,089	47,165	5,624,956
1912	108	406,053	482,501	748,872	34,043,005	481,827	292,705	6,602,032
Increase (+) or decrease (−) in 1912	.....	+160,888	−207,183	−15,872	−2,060,644	+163,738	+245,540	+977,076

[a] Placer production included.

The production from Yavapai County in 1912 by 93 deep-mine operators aggregated 406,053 tons of ore. This is 160,888 tons more than was mined by 94 producers in 1911. The total value of the ore produced in the county amounted to $6,586,029, of which $466,578 was for gold, $460,476 for silver, $5,617,096 for copper, $21,682 for lead, and $20,197 for zinc. There was a decrease in the quantity of gold and silver, including placer production, and of copper produced, but in value the silver output increased $55,242, the copper $1,104,140, the lead $7,368, and the zinc $17,509. The total net increase in the output of these metals was $977,076. The total average value per ton decreased from $22.91 in 1911 to $16.22 in 1912, and the gold and silver values in this ore from $4.42 to $2.28 per ton. The larger part of the ore output was treated at smelters and aggregated 387,996 tons, of which 546 tons were siliceous ores, 7,333 tons oxidized copper ores, 379,081 tons sulphide copper ores, 15 tons lead oxidized ores, 536 tons sulphide lead ores, and 485 tons sulphide lead-zinc ores. The total value of these ores shipped to the smelters amounted to $6,390,317, with a total average value per ton of $16.47. Ores treated at concentration mills aggregated 7,275 tons and produced 1,072 tons of concentrates, containing $53,043 in gold, 113,703 ounces of silver, 15,785 pounds of copper, and 124,241 pounds of lead, valued in all at $131,167, or an average value of $122.36 per ton. The ores treated at gold and silver mills aggregated 10,782 tons, and produced $64,116 in gold and 697 ounces of silver, also 396 tons of concentrates containing 1,656.94 ounces of gold, 2,382 ounces of silver, 7,529 pounds

of copper, and 42,960 pounds of lead. The United Verde smelter at Jerome treated the largest part of the copper ore, which was entirely from United Verde properties. Ores were also shipped to the Humboldt smelter and to Swansea in Yuma County; to Needles, Cal.; and to El Paso, Tex. The placer yield of 1912 reported from 15 sources, which was the same number producing in 1911, gave a production of $15,923 in gold and 130 ounces of silver, as against a production of $9,581 in gold and 44 ounces of silver in 1911.

Agua Fria district.—Two producers of oxidized and sulphide copper ore made shipments of ore to local smelters.

Big Bug district.—Mines in this district in 1912 produced 23,480 tons of ore, containing $40,639 in gold, 27,086 ounces of silver, 1,216,074 pounds of copper, and 54,343 pounds of lead, valued in all at $260,394. Included in this was the output of placers from different sources amounting to $6,164 in gold and 46 ounces of silver. Of the ore mined in the district the larger part, or 23,137 tons, was shipped to smelters and 343 tons were milled, producing gold bullion and lead concentrates. The ore of shipping grade mined was principally sulphide, and the gold ores milled were dry or siliceous in character and carried some iron pyrite and small quantities of lead, saved by concentration. The principal producers were the Blue Bell, Gladstone & McCabe, Independent, Lelan, Little Jack, Malachite, and the Poland property, operated by lessees.

Black Canyon district.—The Silver Cord was the principal producer in this district in 1912. In all 224 tons of ore were shipped by 3 producers and averaged $40.67 per ton for gold, silver, copper, and lead.

Black Rock district.—Seven producers shipped principally copper oxidized ore and some lead ore directly to the smelters, the output aggregating 167 tons, which contained $426 in gold, 3,215 ounces of silver, 17,637 pounds of copper, and 67,737 pounds of lead, valued in all at $8,361, or an average value per ton of $50.06. The Big Blue, Thompson, Red Bluff, and Copper Belt mines were the principal producers.

Blue Tank district.—Oxidized copper ore was shipped from the Great Northern property and contained, besides copper, values in silver and gold.

Bradshaw district.—One producer shipped gold and silver bullion and sulphide copper ore carrying considerable values in gold.

Cherry Creek district.—The largest operations were at the Statehood or Monarch property, which was opened up in June and the old workings of which have been retimbered. Old tailings at the mill on the property were re-treated by the cyanide process. A 5-stamp concentration mill was improved by the addition of a 15-ton cyanide plant. Gold bullion was produced from two other properties in the district.

Copper Basin district.—An important tonnage of copper oxidized ore was mined and shipped to Douglas and Hayden from the Senator and Copper Basin mines of the Commercial Mining Co. These ores carried small values in silver and gold, but some were very rich in copper. Oxidized lead ore with gold and silver values was shipped from the United States Navy property.

Eureka district.—Very little ore was produced in the district during 1912, and the small quantity mined was treated at milling plants, producing principally gold bullion and some concentrates. The output was reported to have come mostly from the Nieman & Cyglance and Hillside properties. The Ruth property produced zinc-lead ore, which was shipped to an eastern plant.

Hassayampa district.—Ten producers reported the output of 2,570 tons of ore, the larger part of which was treated at gold and silver mills, producing bullion, and a small part was concentrated. The total output contained $22,016 in gold, 14,916 ounces of silver, 68,519 pounds of copper, 157,706 pounds of lead, and 292,705 pounds of zinc, valued in all at $69,789, or an average value per ton of $27.15. The shipments consisted largely of sulphide copper ores, and the siliceous ores were treated at milling plants producing gold bullion and iron concentrates containing small quantities of copper. The Climax mine, equipped with a 10-stamp amalgamating and concentrating mill, was operated and produced both oxide and sulphide ores. The mill was operated intermittently. Gold bullion and iron concentrates were produced from the Champion property, the ore of which was treated in a neighboring mill. The Lookout claims were under lease, producing copper ores with values in gold and silver. The 2-stamp concentration mill on the Juanita property was operated for a short time on ores from that property, producing gold bullion and concentrates containing copper. A small quantity of ore was shipped from the Morgan No. 2, and the Dunkirk was also a producer of milling ore, which was treated in a 4-stamp concentration plant on the property. The Venezia mine was in operation, and the ore produced yielded bullion and concentrates in the 20-stamp amalgamation and concentration mill on the property. Some ore was reported treated at this mill for neighboring properties.

Humbug district.—The production by three producers aggregated 667 tons of ore, part of which was treated at milling plants and yielded bullion. The entire output mined contained $2,503 in gold, 779 ounces of silver, 47,167 pounds of copper, and 13,349 pounds of lead, valued in all at $11,366, or an average value per ton of $17.04. The Columbia Consolidated, Marietta, Farley, and Century properties were the principal producers. Copper sulphide ores mined from the Marietta claim by the Kay Copper Co. formed the principal part of the output of the district.

Martinez district.—The principal output in 1912 was from the United Gold Mines Co., which produced in its 30-ton stamp mill concentrates and precipitates from the cyanidation of the tailings. It is reported that the dump of the Congress mill, consisting of about 850,000 tons of tailings, has been sold and will be treated at the United Verde smelter, where the material will be used for converter lining.

Peck district.—Lessees produced some silver ore from the Peck mine, containing a small quantity of copper, and an important tonnage of lead-silver ore was shipped from the Silver Prince property. This mine is opened by an incline shaft 320 feet deep with drifts 500 and 300 feet long.

Tiger district.—The yield of ore by 6 producers aggregated 11,899 tons, containing $33,574 in gold, 107,530 ounces of silver, 17,731 pounds of copper, and 70,780 pounds of lead, valued in all at $105,816,

or an average value per ton of $8.89. The largest part of these metals was contained in ore shipped from the Old Tiger property operated by the Yavapai Consolidated Mining Co., which is equipped with a 10-stamp concentration plant, in which all of the ore produced was treated, yielding concentrates containing lead, silver, gold, and a small quantity of copper. The mine is developed by a vertical shaft 750 feet deep. Siliceous ore was treated by the cyanide process from the Arizona Mascot property in its 100-ton cyanide slime plant. The ore is ground to 200 mesh and agitated in cyanide solution. The Gray Eagle property of the Tiger Gold Co. produced ore which was treated in its 20-stamp amalgamation and concentration mill, producing concentrate and bullion. A small quantity of sulphide ore containing copper was shipped from the Springfield claim.

Turkey Creek district.—Six mines produced 48 tons of ore, containing gold, silver, and copper valued at $3,351, or an average value per ton of $69.81. About half of the ore was milled, producing bullion and gold and silver concentrates. The most important production was made from the Tunnel claim, and smaller shipments were taken from the Golden Fleece, Copper King, the Holmes, and Thunderbolt properties.

Verde district.—The ores produced in this district are principally sulphides and carry considerable values in gold and silver. The entire production, with the exception of a small tonnage from the Cleopatra property, was produced from the United Verde mine. All of the ore produced by this mine was treated at its own smelter, now being replaced by a larger and more complete plant in the Verde Valley, which is being connected by a branch line from the station on the Santa Fe & Prescott Railroad.

Walker district.—Eight deep-mine producers and five placers yielded an output containing gold, silver, copper, and lead, valued at $11,072. The North Capitol and Pine Mountain properties were the principal producers of ore. The placer production came from various small operators working in the gulches tributary to Lynx Creek.

Walnut Grove district.—The production of oxidized copper ore, containing a small quantity of gold, was shipped from two properties and averaged $24.86 per ton.

Weaver district.—None of the deep mines were operated in the district in 1912, and the only production consisted of gold and silver from dry placers, which are usually worked after rainy seasons by numerous operators. The total value of the output aggregated $4,839, against a production of $4,813 in 1911.

White Picacho district.—Only one small shipment of gold and silver ore was made from the district in 1912. Development was continued at the Monarch mine, which was reported to have about 10,000 tons ready to mill in its concentration plant. The property is developed by tunnels and open cuts.

YUMA COUNTY.

The quantity of ore mined in Yuma County by 41 deep mine producers aggregated 11,310 tons in 1912, which was a decrease of 1,194 tons from that produced in 1911 when 40 producers reported output. The total average value per ton decreased from $20.88 to

$11.27 in 1912, and the gold and silver value in this ore from $16.40 to $3.09 per ton. The total metal yield was valued at $148,139, of which the placers produced $20,489 in gold and the deep mines $29,829 in gold. The mines of the county also produced 8,592 ounces of silver, valued at $5,284; 494,235 pounds of copper, valued at $81,549; and 244,170 pounds of lead, valued at $10,988. There was a decrease in quantity of gold and silver, but the copper and lead showed increase. The largest part of the tonnage mined, or 10,706 tons, was treated at the Swansea and Humboldt smelters. The closing of the King of Arizona and North Star mines caused a large decrease in the tonnage of ore mined and in the total value of the county output. According to the estimates made, there were only 399 tons of crude ores treated at cyanide and amalgamation mills, from which was recovered $8,152 in gold and 91 ounces of silver. The dry placers in the Quartzsite region produced more gold than in 1911, the output increasing from 342.84 ounces to 991.16 ounces in 1912. The geology of the northern part of the county is described in a paper[1] published by the Survey.

Castle Dome district.—Thirteen producers, including placer producers, reported a yield of $6,495 in gold, 5,702 ounces of silver, 111 pounds of copper, and 239,753 pounds of lead, valued in all at $20,808.

Cienega district.—The output of 8 deep mines aggregated $7,885 from the production of 86 tons of shipping ore and 205 tons of tailings. The Ruby, Juanita, and Nellie properties were operated.

Ellsworth district.—The production of 6 deep mines aggregated 308 tons of ore, which, with the output of the placers, was valued at $14,557, consisting of $5,208 in gold, 256 ounces of silver, and 55,703 pounds of copper.

Kofa district.—The closing of the North Star and King of Arizona mines reduced the production of ore to a very low tonnage. Most of it was milled, but a small part was shipped directly to smelters. The output of the district, valued at $18,996, is partly estimated for the reason that one producer failed to give details.

Laguna district.—The gold and silver from placer operations is estimated at $1,975 in gold and 22 ounces of silver.

La Paz district.—Development work was carried on at one of the principal properties, but a very small placer production was reported.

Palomas district.—The Silver Prince property, near Palomas, in what is locally known as the Never Sweat district, yielded oxidized lead ore carrying silver and gold.

Planet district.—Considerable activity was caused by the opening of the Swansea smelter, which was operated on Swansea ores and on other ores purchased for fluxing purposes. The output of the district aggregated 9,867 tons, containing gold, silver, and copper.

Plomosa district.—Seven deep mine producers reported the yield of 128 tons of ore carrying gold, silver, and copper. Half of the ore was treated in a milling plant and produced gold and silver bullion. The placer production amounted to $9,472 in gold and 83 ounces of silver. The total output of the district aggregated $13,576.

[1] Bancroft, Howland, Reconnaissance of the ore deposits in northern Yuma County, Ariz.: Bull. U. S. Geol. Survey No. 451, 1911, 130 pp.

CALIFORNIA.

By Charles G. Yale.

PRODUCTION.

Number of mines producing in California, quantity of ore sold or treated in 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	1,139	2,696,603	$18,898,545	1,076,174	16,697,544	447,723	.....	$22,174,413
1906	1,017	2,556,056	18,732,452	1,220,641	28,726,448	338,718	206,000	25,126,359
1907	1,061	2,054,653	16,727,928	1,138,858	28,528,020	2,625,419	233,550	23,338,104
1908	1,054	2,546,908	18,761,559	1,647,278	38,776,881	1,237,548	.....	24,805,141
1909	1,127	3,041,688	20,237,870	2,098,253	57,288,281	1,502,597	.....	28,841,050
1910	1,079	2,697,885	19,715,440	1,840,085	48,700,756	2,870,977	.....	27,020,405
1911	1,181	2,797,261	19,738,908	1,270,445	36,316,136	1,398,111	2,807,035	25,174,677
1912	1,041	2,641,497	19,713,478	1,300,136	33,451,672	1,144,731	4,345,591	26,383,946
Increase (+) or decrease (−) in 1912	−140	−155,764	−25,430	+29,691	−2,864,464	−253,380	+1,538,556	+1,209,269

It is to be noted in connection with this tabular statement of the production of metals in California that all the quantities, with the exception of silver and zinc, show a decrease for the year 1912 as compared with 1911, yet that the total value shows a material increase. The value of the gold output shows a decrease of $25,430 and that of the lead a decrease of $11,403. The silver value in 1911 was $673,336; in 1912 this value was $799,584, an increase for 1912 of $126,248. The value of the copper in 1911 was $4,539,517; in 1912 it was $5,519,526, an increase for 1912 of $980,009. In 1911 the value of the zinc output was $160,001; in 1912 it was $299,846, an increase for 1912 of $139,845.

In connection with this table also and similar uniform tables following in this chapter where the separate counties are considered, it must be borne in mind that the gold values and the silver quantities bear no relation to the figures of tonnage, although the other substances do. The reason is that not only deep-mine gold and silver but also placer-mine gold and silver are combined under the respective headings of these metals in the general tables. Other tables are provided, however, to show the details. For example, in the table above the total gold output for 1912 is shown as $19,713,478, of which $11,067,815 was derived from deep mines and $8,645,663 from placers of various kinds. In the same way, of the total silver output of 1,300,136 fine ounces, 1,264,484 fine ounces were from deep mines and 35,652 from the placers. In number of productive mines, both deep and placer mines are stated.

In 1912 there were 1,041 properties reporting production, of which 532 were deep mines and 509 were placers. There were 140 less producing mines in 1912 than in 1911. The producing deep mines of

1912 may be classified by metal product as follows: Gold, 470; copper, 24; silver, 12; silver-lead-zinc, 25; zinc, 1. Of the placer mines 141 are hydraulic, 65 dredges, 146 drift, and 157 surface. There were 76 fewer placers operating in 1912 than in 1911. There were less deep mines operating than in 1911, among which 52 were gold mines, 6 copper, 8 silver-lead-zinc, and 1 zinc. The dredges are enumerated by the number of boats at work, some companies owning several and some only one. There were 28 fewer hydraulic mines productive in 1912 than in 1911, and 53 less surface placers; the number of dredges remained the same. There were 5 more drift mines in 1912 than in 1911.

The 532 deep mines producing in the State in 1912 made an output of 2,641,497 tons of ore, 155,764 fewer than in 1911. Of this output, 2,225,429 tons were siliceous ore, 408,622 tons copper ore, 974 tons lead ore, and 6,472 tons zinc ore. The siliceous ore output decreased by 70,918 tons, the copper ore decreased by 85,659 tons, the lead ore decreased by 1,034 tons, and the zinc ore increased by 1,847 tons.

The siliceous ore yielded an average per ton in gold and silver of $4.95; the copper ore, $1.91; the lead ore, $24.18; and the zinc ore, $2.59. The average in gold and silver value from all ores treated in the State in 1912 was $4.49 per ton.

The 2,641,497 tons of ore of all classes treated in California in 1912 yielded 535,405.55 fine ounces of gold, valued at $11,067,815; 1,264,484 ounces of silver, valued at $777,658; 33,451,672 pounds of copper, valued at $5,519,526; 1,144,731 pounds of lead, valued at $51,512; and 4,345,591 pounds of zinc, valued at $299,846.

The value of all metals obtained from ore mined and treated in California in 1912 was $17,716,357, an average value of $6.71 per ton. In 1911 the output was valued at $16,167,193, from 2,797,261 tons of ore of all classes, an average value per ton of $5.49; in 1910 the output was 2,697,885 tons, valued at $18,109,008, an average value of $6.71 per ton; in 1909 it was 3,041,688 tons, valued at $19,715,314, an average of $6.48 per ton; and in 1908 it was 2,546,908 tons, valued at $16,536,226, an average value per ton of $6.49.

In 1912 there were treated at gold and silver mills 2,077,300 tons of ore, containing altogether $10,371,347 in gold, an average value of $4.99 per ton, and 307,306 ounces of silver, valued at $188,993, an average value of 9 cents per ton. This gives a total value of $10,560,340 in gold and silver thus treated, and an average value per ton of $5.08 in both metals. The average value in 1911 was $4.64 per ton; in 1910 it was $5.25; in 1909 it was $4.88; and in 1908 it was $5.08.

There was recovered as bullion in the mills $8,526,229 in gold, averaging $4.11 per ton, and 247,520 ounces of silver, valued at $152,225, averaging 7 cents per ton, a total of $8,678,454 in gold and silver, averaging $4.17 per ton in both metals.

From 2,077,300 tons of gold milling ore, 38,373 tons of concentrates were obtained, valued at $1,845,118 in gold, an average of $48.08 per ton, and 59,786 ounces of silver, valued at $36,768, an average of 96 cents per ton. This was a yield in gold and silver valued at $1,881,886 or an average value recovered from the concentrates of $49.04 per ton in gold and silver.

Of smelting ores there were 456,735 tons produced, with an output of $592,532 in gold, an average of $1 30 per ton, and of 955,067 fine

ounces of silver, valued at $587,366, an average recovery of $1.29 per ton. The total yield of gold and silver in the smelting ores was $1,179,898, or an average of $2.59 per ton.

There were treated also 107,462 tons of old tailings, producing $103,936 in gold, an average of 96 cents per ton, and 2,111 ounces of silver, valued at $1,298, an average of 1 cent per ton. The total gold and silver produced from the tailings was valued at $105,234, an average of 97 cents per ton.

The 509 productive placer mines in California in 1912 yielded 418,233.95 fine ounces of gold, valued at $8,645,663, and 35,652 ounces of silver, valued at $21,926, a total value in gold and silver of $8,667,589. This was a decrease of $339,895 from the placer output of 1911. The gold decrease was $340,864, but the value of the silver output increased by $969. In gold production the dredge properties showed a decrease of $236,506 in 1912, and the hydraulic mines an increase of $14,196. In the same period the drift mines showed a decrease of $91,908 and the surface placer or sluicing mines a decrease of $26,646.

The following table shows the production of gold, silver, copper, lead, and zinc in California in 1912, by counties:

Production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California, in 1912.

County.	Ore treated.	Deep-mine gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine oz.*		*Fine oz.*		*Fine oz.*	
Alpine	1,200	85.33	$1,764			85.33	$1,764
Amador	737,148	134,553.42	2,781,466	712.47	$14,728	135,265.89	2,796,194
Butte	3,326	1,030.44	21,301	112,468.39	2,324,928	113,498.83	2,346,229
Calaveras	430,128	36,209.22	748,511	10,334.54	213,634	46,543.76	962,145
Del Norte				190.60	3,940	190.60	3,940
Eldorado	8,871	2,075.29	42,900	3,031.42	62,665	5,106.71	105,565
Fresno	603	294.80	6,094			294.80	6,094
Humboldt	50	14.51	300	1,498.22	30,971	1,512.73	31,271
Inyo	70,615	17,887.04	369,758			17,887.04	369,758
Kern	168,226	40,042.41	827,750	129.16	2,670	40,171.57	830,420
Los Angeles	457	156.54	3,236			156.54	3,236
Madera	1,580	443.21	9,162			443.21	9,162
Mariposa	21,094	7,613.02	157,375	153.16	3,166	7,766.18	160,541
Merced, Shasta, Siskiyou, and Stanislaus				15,790.52	326,419	15,790.52	326,419
Modoc	2,171	1,349.32	27,893			1,349.32	27,893
Mono	32,399	18,262.43	377,518			18,262.43	377,518
Monterey	267	159.44	3,296	6.72	139	166.16	3,435
Nevada	270,148	98,532.23	2,036,842	2,182.49	45,116	100,714.72	2,081,958
Placer	27,729	5,938.66	122,763	11,833.49	244,620	17,772.15	367,383
Plumas	27,398	5,286.52	109,282	4,061.32	83,955	9,347.84	193,237
Riverside	1,645	977.27	20,202			977.27	20,202
Sacramento				82,846.40	1,712,587	82,846.40	1,712,587
San Bernardino	44,722	14,180.65	293,140	36.77	760	14,217.42	293,900
San Luis Obispo				47.21	976	47.21	976
Shasta	415,116	44,652.16	923,042	251.60	5,201	44,903.76	928,243
Sierra	76,606	29,822.46	616,485	5,635.83	116,503	35,458.29	732,988
Siskiyou	13,160	9,213.99	190,470	11,597 81	239,748	20,811.80	430,218
Trinity	57,307	12,449.64	257,357	22,549.81	466, 46	34,999.45	723,503
Tuolumne	228,823	55,563.32	1,107,252	292.14	6,039	53,855.46	1,113,291
Yuba	708	612.23	12,656	132, 83.88	2,740,752	133,196.11	2,753,408
Total	2,641,497	535,405.55	11,067,815	418,233.95	8,645,663	953,639.50	19,713,478

Production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California, in 1912—Continued.

County.	Deep-mine silver.		Placer silver.		Total silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine oz.		*Fine oz.*		*Fine oz.*		*Pounds.*	
Alpine	2,300	$1,415			2,300	$1,415		
Amador	51,948	31,948	145	$89	52,093	32,037	175,542	$28,964
Butte	207	127	8,846	5,440	9,053	5,567		
Calaveras	114,047	70,139	990	609	115,037	70,748	6,089,819	1,004,820
Del Norte			16	10	16	10		
Eldorado	1,015	624	356	219	1,371	843		
Fresno	37	23			37	23		
Humboldt	16	10	227	140	243	150		
Inyo	73,685	45,316			73,685	45,316	45,033	7,431
Kern	18,652	11,471	15	9	18,667	11,480	1,064	176
Los Angeles	64	39			64	39		
Madera	1,890	1,162			1,890	1,162	232,347	38,337
Mariposa	11,018	6,776	33	20	11,051	6,796	300,062	49,510
Merced, Shasta, Siskiyou, and Stanislaus			1,619	995	1,619	995		
Modoc	803	494			803	494		
Mono	114,800	70,602			114,800	70,602	7,866	1,298
Monterey	36	22	2	1	38	23		
Nevada	36,738	22,594	384	236	37,122	22,830		
Placer	6,320	3,887	1,470	904	7,790	4,791	75,000	12,375
Plumas	1,159	713	397	244	1,556	957	16,381	2,703
Riverside	413	254			413	254		
Sacramento			5,762	3,544	5,762	3,544		
San Bernardino	81,235	49,960	3	2	81,238	49,962	1,890,008	311,852
San Luis Obispo			8	5	8	5		
Shasta	691,210	425,094	47	29	691,257	425,123	24,618,550	4,062,060
Sierra	3,878	2,385	637	392	4,515	2,777		
Siskiyou	2,582	1,588	1,975	1,215	4,557	2,803		
Trinity	9,478	5,829	2,707	1,665	12,185	7,494		
Tuolumne	40,851	25,123	37	23	40,888	25,146		
Yuba	102	63	9,976	6,135	10,078	6,198		
Total	1,264,484	777,658	35,652	21,926	1,300,136	799,584	33,451,672	5,519,526

County.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Alpine					$3,179
Amador					2,857,195
Butte					2,351,796
Calaveras					2,037,713
Del Norte					3,950
Eldorado					106,408
Fresno					6,117
Humboldt					31,421
Inyo	997,999	$44,910	4,345,591	$299,846	767,261
Kern	20,011	900			842,976
Los Angeles					3,275
Madera					48,661
Mariposa					216,847
Merced, Shasta, Siskiyou, and Stanislaus					327,414
Modoc					28,387
Mono	24,445	1,100			450,518
Monterey					3,458
Nevada					2,104,788
Placer					384,549
Plumas	5,837	263			197,160
Riverside					20,456
Sacramento					1,716,131
San Bernardino	96,439	4,339			660,053
San Luis Obispo					981
Shasta					5,415,426
Sierra					735,765
Siskiyou					433,021
Trinity					730,997
Tuolumne					1,138,437
Yuba					2,759,606
Total	1,144,731	51,512	4,345,591	299,846	26,383,946

GOLD.

The total gold production in California in 1912 was 953,639.5 fine ounces, valued at $19,713,478, as compared with 954,869.67 fine ounces, valued at $19,738,908, in 1911, a decrease of 1,200.17 fine ounces, valued at $25,430, for 1912. The deep mines of the State yielded 535,405.55 fine ounces, valued at $11,067,815. Of the deep-mine gold, 521,083.83 fine ounces, valued at $10,771,759, was derived from siliceous ore; 14,219.65 fine ounces, valued at $293,946, from copper ore; 83.06 fine ounces, valued at $1,717, from lead ore; and 19.01 fine ounces, valued at $393, from zinc ore.

The total placer yield of gold in 1912 was 418,233.95 fine ounces, valued at $8,645,663. Of this, $689,682 was derived from 141 hydraulic mines; $7,429,955 was from 65 dredges; $387,992 from 146 drift mines; and $138,034 from 157 surface or sluicing mines. The deep mines of California produced $2,422,152 more gold than the combined placers of the State in 1912. The placers produced 43.86 per cent of the entire gold yield for 1912, and the deep mines 56.14 per cent, as compared with 45.53 per cent for the placers in 1911, and 54.47 per cent for the deep mines.

The dredges in the State produced 37.68 per cent of the total gold yield from all sources in 1912. Of total placer gold, the dredges produced 85.93 per cent; the hydraulic mines, 7.98 per cent; the drift mines, 4.49 per cent; and the surface or sluicing mines, 1.60 per cent. The dredge mining record for the last 14 years is shown in the table following, with the increase or decrease for each year:

Value of gold won by dredging in California, 1899–1912, with increase (+) or decrease (−) by years.

Year.	Value.	Increase (+) or decrease (−).
1899	$206,302	
1900	200,929	− $5,373
1901	471,762	+ 270,833
1902	867,665	+ 395,903
1903	1,475,749	+ 608,084
1904	2,187,038	+ 711,289
1905	3,276,141	+1,089,103
1906	5,098,359	+1,822,218
1907	5,065,437	− 32,822
1908	6,536,189	+1,470,752
1909	7,382,950	+ 846,761
1910	7,550,254	+ 167,304
1911	7,666,461	+ 116,207
1912	7,429,955	− 236,506
Total	55,415,191	

The three great dredging fields of the State are at Oroville, Butte County; Folsom, Sacramento County; and near Marysville, Yuba County. Dredges are also operated in seven other counties, but mainly in isolated localities with only one or two dredges at work in each. The only exception to this is at Jenny Lind, Calaveras County, where there were three dredges at work during 1912. In these districts outside of the main, and more important fields, the dredges are not usually of such large digging capacity as those in fields where there are numerous dredges. The Yuba County field decreased its

annual output of gold in 1912 by $248,540. Butte County, as a whole, increased its dredge yield by $20,232, and the Oroville field alone by $92,935. Sacramento County decreased by $132,274. In Yuba County there were 14 dredges operating in 1912, as compared with 13 in 1911; in Butte County there were 28 dredges, as compared with 30 in 1911; and in Sacramento County there were 11 dredges, as compared with 10 in 1911. There were three in Calaveras County, 3 in Placer County, and 2 in Trinity County. In Merced, Shasta, Siskiyou, and Stanislaus counties there was 1 dredge each at work. The details of such changes as have occurred will be described under the headings of the respective counties where dredging has been carried on in 1912.

Of the 31 counties producing gold in California in 1912, 8 yielded no placer gold and 5 yielded no gold from deep mines. Six counties yielded over $1,000,000 each in gold in 1912, as follows: Amador, $2,796,194; Yuba, $2,753,408; Butte, $2,346,229; Nevada, $2,081,958; Sacramento, $1,712,587; and Tuolumne, $1,113,291.

The largest production of gold in California in 1912 came, as shown, from Amador County, which took precedence over Yuba County, which ranked first in 1911. The leading hydraulic mining county was Trinity; the greatest producer of gold from drift mines was Placer; the largest producer of gold from dredges and from surface or sluicing mines was Yuba County. The largest increase in total gold yield in 1912 was Kern County, with an increase of $272,949, followed by Sierra, with $271,475; San Bernardino, with $166,533; Mono, with $116,286; Placer, with $116,085; and Trinity, with $110,403. Some counties showed a decreased yield of gold for the year, as Yuba, $243,664; Inyo, $205,187; Calaveras, $150,170; Shasta, $146,673; Nevada, $117,189; and Sacramento, $100,239. No gold whatever was reported produced in Lassen, Imperial, San Diego, or Colusa counties, formerly productive.

The production of gold from placers and from different kinds of ore in California in 1912, by counties, in fine ounces, is given in the following table:

Source of gold production in California by kinds of ore in 1912, by counties, in fine ounces.

County.	Placers.	Deep mines.					Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Total.	
Alpine		85.33				85.33	85.33
Amador	712.47	134,037.26	516.16			134,553.42	135,265.89
Butte	112,468.39	1,030.44				1,030.44	113,498.83
Calaveras	10,334.54	33,559.04	2,650.18			36,209.22	46,543.76
Del Norte	190.60						190.60
Eldorado	3,031.42	2,075.29				2,075.29	5,106.71
Fresno		294.80				294.80	294.80
Humboldt	1,498.22	14.51				14.51	1,512.73
Inyo		17,795.22	16.50	56.31	19.01	17,887.04	17,887.04
Kern	129.16	40,041.78		.63		40,042.41	40,171.57
Los Angeles		156.54				156.54	156.54
Madera		435.13	8.08			443.21	443.21
Mariposa	153.16	7,508.68	104.34			7,613.02	7,766.18
Merced, Shasta, Siskiyou, and Stanislaus	15,790.52						15,790.52
Modoc		1,349.32				1,349.32	1,349.32
Mono		18,220.93	15.38	26.12		18,262.43	18,262.43
Monterey	6.72	159.44				159.44	166.16
Nevada	2,182.49	98,532.23				98,532.23	100,714.72
Placer	11,833.49	5,743.27	195.39			5,938.66	17,772.15
Plumas	4,061.32	5,286.52				5,286.52	9,347.84
Riverside		977.27				977.27	977.27
Sacramento	82,846.40						82,846.40
San Bernardino	36.77	14,147.03	33.62			14,180.65	14,217.42
San Luis Obispo	47.21						47.21
Shasta	251.60	33,972.16	10,680.00			44,652.16	44,903.76
Sierra	5,635.83	29,822.46				29,822.46	35,458.29
Siskiyou	11,597.81	9,213.99				9,213.99	20,811.80
Trinity	22,549.81	12,449.64				12,449.64	34,999.45
Tuolumne	292.14	53,563.32				53,563.32	53,855.46
Yuba	132,583.88	612.23				612.23	133,196.11
Total	418,233.95	521,083.83	14,219.65	83.06	19.01	535,405.55	953,639.50

Comparisons of these totals with the gold output of 1911 are as follows:

Mine production of gold in California in 1911 and 1912, with classification of source, in fine ounces.

Year.	Placers.	Deep mines.					Grand total.	
		Siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Total.	Quantity.	Value.
1911	434,723.24	499,123.29	20,694.28	328.86		520,146.43	954,869.67	$19,738,908
1912	418,233.95	521,083.83	14,219.65	83.06	19.01	535,405.55	953,639.50	19,713,478
Increase (+) or decrease (−)	−26,489.29	+21,960.54	−6,474.63	−245.80	+19.01	+15,259.12	−1,230.17	−25,430

From the siliceous ore and from old tailings the recovery of gold by processes in California in 1912 was as follows: By amalgamation, 391,421.44 fine ounces, valued at $8,091,402; by cyanidation, 51,423.24 fine ounces, valued at $1,063,011; and by chlorination, 15,735.01 fine ounces, valued at $325,271. There were but two chlorination plants operated in the State in 1912, and 30 reduction mills had cyanide plants connected with them. There were also several separate plants where old tailings were treated by the cyanide process. Gold valued at $592,532 was obtained from smelting ores, and $995,599 in gold

was obtained from concentrates treated at custom reduction plants and smelters.

The source of placer gold, by counties and from various kinds of mines, is shown as follows:

Source of placer gold in California in 1912, by counties.

County.	Hydraulic.	Dredging.	Drift.	Surface placers.	Total.
Amador	$221		$10,236	$4,271	$14,728
Butte	7,205	$2,271,996	31,545	14,182	2,324,928
Calaveras	7,081	175,636	21,134	9,783	213,634
Del Norte	1,313			2,627	3,940
Eldorado	1,100		54,759	6,806	62,665
Humboldt	30,680			291	30,971
Kern				2,670	2,670
Mariposa			415	2,751	3,166
Merced, Shasta, Siskiyou, and Stanislaus [a]		326,419			326,419
Monterey and San Luis Obispo				1,115	1,115
Nevada	18,767		14,154	12,195	45,116
Placer	36,291	92,378	102,895	13,056	244,620
Plumas	16,963		56,931	10,061	83,955
Sacramento		1,672,797	39,790		1,712,587
San Bernardino				760	760
Shasta			1,655	3,546	5,201
Sierra	78,779		34,237	3,487	116,503
Siskiyou	217,043		9,181	13,524	239,748
Trinity	274,239	174,532	2,881	14,494	466,146
Tuolumne			6,039		6,039
Yuba		2,716,197	2,140	22,415	2,740,752
Total	689,682	7,429,955	387,992	138,034	8,645,663

[a] Yield of single dredge in each county combined to conceal separate output.

The increase or decrease of gold production, by counties, in 1912 as compared with 1911, is shown in the following table:

Increase and decrease in gold production in California in 1912, by counties.

County.	Increase.	Decrease.
Alpine	$1,764	
Amador		$36,201
Butte	22,833	
Calaveras		150,170
Del Norte	2,197	
Eldorado		28,402
Fresno		11,347
Humboldt		3,695
Inyo		205,187
Kern	272,949	
Los Angeles		2,414
Madera	7,204	
Mariposa		11,991
Merced	19,613	
Modoc	8,018	
Mono	116,286	
Monterey	3,435	
Nevada		117,189
Placer	116,085	
Plumas		35,548
Riverside	5,229	
Sacramento		100,239
San Bernardino	166,533	
San Luis Obispo	976	
Shasta		146,673
Sierra	271,475	
Siskiyou	50,017	
Stanislaus		26,842
Trinity	110,403	
Tuolumne	19,807	
Yuba		243,664
Colusa, Lassen, Imperial, and San Diego		100,692
Total	1,194,824	1,220,254
Total decrease		25,430

SILVER.

The yield of silver in California in 1912 was 1,300,136 fine ounces, valued at $799,584, an increase in quantity of 29,691 fine ounces and in value of $126,248. The larger portion of the output, or 955,067 ounces, valued at $587,366, was derived from crude smelting ores. The output of siliceous ore, both milled and smelted, yielded 409,873 fine ounces, valued at $252,072. The largest production of siliceous ore, 100,291 ounces, valued at $61,679, came from Mono County. The largest production of silver was, as usual, from Shasta County, which yielded from the smelting of copper ores 684,381 fine ounces, valued at $420,894, 6,829 ounces from siliceous ore, and 468 ounces from placers—a total yield from the county of 691,678 fine ounces, valued at $425,382. In 1911 Shasta County produced 730,675 ounces of silver, valued at $387,257, the decrease for 1912 in quantity being 38,997 ounces, while the increase in value for the same period was $38,125. The restricted operation of the smelters in Shasta County explains the lessened copper output in 1912, and this directly affected the silver production. The silver obtained with the gold in placer mining in the State in 1912 was 35,652 fine ounces, valued at $21,926, as compared with 39,541 ounces in 1911, valued at $20,957. The largest producer of placer silver was Yuba County, with 9,976 ounces, valued at $6,135.

The following table shows the source of silver output in California in 1912, by placers and kinds of ore, in fine ounces:

Source of silver production in California, by kinds of ore, in 1912, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Total.	
Alpine		2,300				2,300	2,300
Amador	145	50,515	1,433			51,948	52,093
Butte	8,846	207				207	9,053
Calaveras	990	16,228	97,819			114,047	115,037
Del Norte	16						16
Eldorado	356	1,015				1,015	1,371
Fresno		37				37	37
Humboldt	227	16				16	243
Inyo		22,598	3,124	21,289	26,674	73,685	73,685
Kern	15	18,495	11	146		18,652	18,667
Los Angeles		64				64	64
Madera		1,111	779			1,890	1,890
Mariposa	33	7,221	3,797			11,018	11,051
Merced, Shasta, Siskiyou, and Stanislaus[a]	1,619						1,619
Modoc		803				803	803
Mono		100,291	452	14,057		114,800	114,800
Monterey	2	36				36	38
Nevada	384	36,738				36,738	37,122
Placer	1,470	5,917	403			6,320	7,790
Plumas	397	1,126	33			1,159	1,556
Riverside		413				413	413
Sacramento	5,762						5,762
San Bernardino	3	81,022	213			81,235	81,238
San Luis Obispo	8						8
Shasta	47	6,829	684,381			691,210	691,257
Sierra	637	3,878				3,878	4,515
Siskiyou	1,975	2,582				2,582	4,557
Trinity	2,707	9,478				9,478	12,185
Tuolumne	37	40,851				40,851	40,888
Yuba	9,976	102				102	10,078
Total	35,652	409,873	792,445	35,492	26,674	1,264,484	1,300,136

[a] Combined to conceal output of a single dredge.

Comparison of these totals for 1912 with the silver output of 1911 is as follows:

Mine production of silver in California in 1911 and 1912, with classification of source, in fine ounces.

Year.	Placers.	Deep mines.					Total.	
		Siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Total.	Quantity.	Value.
1911	39,541	291,896	864,397	74,611	.....	1,230,904	1,270,445	$673,336
1912	35,652	409,873	792,445	35,492	26,674	1,264,484	1,300,136	799,584
Increase (+) or decrease (−)	−3,889	+117,977	−71,952	−39,119	+26,674	+33,580	+29,691	+126,248

From the siliceous ore and old tailings treated in California in 1912 the recovery of silver by amalgamation was 213,999 fine ounces, valued at $132,528; by cyanidation, 72,715 ounces, valued at $44,720; and by chlorination, 1,728 ounces, valued at $1,063. As the total silver from deep mines was $777,658, and that from smelting ore $587,366, this leaves 19,484 ounces or $11,981 in value of silver obtained from concentrates treated at custom reduction works and smelters.

COPPER.

The mine production of copper in California in 1912 was 33,451,672 pounds, valued at $5,519,526, a decrease of 2,864,464 pounds in quantity, but an increase of $980,009 in value. Copper was produced in Amador, Calaveras, Inyo, Kern, Madera, Mariposa, Mono, Placer, Plumas, San Bernardino, and Shasta counties. The heaviest production, as usual, was from Shasta County but the quantity of output there was materially reduced, owing to smelter-fume litigation and the resultant closing down of certain smelting plants. In 1912 the output of Shasta County was 24,618,550 pounds of copper, valued at $4,062,060, which is 4,999,482 pounds less in quantity than in 1911, but an increase in value of $359,806. There were 45 mines producing copper in California in 1912. Altogether 408,622 tons of copper ore were treated, or 85,659 tons less than in 1911; in 1911 there were 222,404 tons less than in 1910; and in 1910 there were 123,673 tons less than in 1909. The smelter-fume litigation and the injunctions in that connection have materially influenced the copper output of the State. This condition has not only affected producing mines, but has prevented the opening and development of others. The copper ores in California in 1912, yielded, in addition to the copper, 14,219.65 fine ounces of gold, valued at $293,946, and 792,445 fine ounces of silver, valued at $487,354.

LEAD.

The lead production in California in 1912 was 1,144,731 pounds, valued at $51,512, a decrease of 253,380 pounds in quantity and of $11,403 in value. By far the larger proportion of the lead, was as usual, from Inyo County, although some also came from Kern, Mono,

Plumas, and San Bernardino counties. From the lead ore was obtained also 83.06 fine ounces of gold, valued at $1,717, and 35,492 ounces of silver, valued at $21,828. The total value of the output of the lead industry of the State in 1912, in lead and contained gold and silver, was $75,057.

ZINC.

The production of zinc in California in 1912 was 4,345,591 pounds, valued at $299,846, as compared with 2,807,035 pounds in 1911, valued at $160,001, an increase for 1912 of 1,538,556 pounds in quantity and of $139,845 in value. Most of this zinc came from one mine, the ores of which were shipped for treatment to reduction works at Springfield, Ill., Argentine and Neodesha, Kans., and Collinsville, Okla. Altogether there were only three mines in the State which produced any zinc in 1912.

THE MINING AND METALLURGICAL INDUSTRIES IN CALIFORNIA IN 1912.

The total value of gold, silver, copper, lead, and zinc produced in California in 1912 shows an increase of $1,209,269, as compared with the year 1911, while in 1911 there was a decrease in the total of $1,845,728, as compared with 1910, and in 1910 there was a decrease in total value of $1,820,645, as compared with 1909. The showing for 1912 is therefore a satisfactory one and may be rightly attributed to a gain in yield from the deep gold mines, to the increased values of copper and zinc production, and to the higher price realized from the silver output. The deep mines produced $315,434 more gold in 1912 than in 1911; the value of the silver output was $126,248 more; the copper output increased by $980,009 in value; and the zinc by $139,845. The greatest gain was therefore in the value of the copper output, owing to the advance in commercial prices, as the quantity of metal produced was materially less in 1912 than in 1911. There was a much larger output of zinc, which also brought better prices in 1912 than in 1911. Several of the large copper smelting plants continue idle, owing to enforcement of injunctions in connection with smelter-fume litigation. Experimental work has been carried on for some time at the plant of the Bully Hill Copper Mining & Smelting Co., Winthrop, Shasta County, in the attempt to produce a metallic zinc from their ores by an electrolytic process. The chemical part of the work has been thoroughly solved on a commercial scale, and the problem of electrolytic precipitation has been apparently solved. No copper smelting has been done at the mine for some time. In the same county, since the close of 1912, arrangements have been made to start up again the smelter of the Balaklala Copper Co., which has been closed down. The company has been conducting experiments to get rid of noxious fumes, and considers itself warranted, from the results, in resuming operations. At the Penn Mining Co.'s copper smelter, Campo Seco, Calaveras County, the Thiogen Co. has been testing a process with a view to rendering smelter fumes harmless. Detailed results of the tests have not, thus far, been made public.

Changes and conditions in the output of the gold-mining industry of the State have already been considered under the heading of

"Gold" in this section. Generally speaking, however, it may be considered to be in a satisfactory condition, although no great advance can be said to have been made in either deep or placer mining. The decrease in gold output of $25,430 is merely nominal, considered in proportion to the total yield of 1912 of $19,713,478, and simply indicates that gold mining in California remains as it has been for several years. The percentage of output of both placers and deep gold mines remains virtually unchanged from previous years. No marked changes in the dredging industry are to be noted. Although two of the larger fields, Yuba and Sacramento, show a combined decrease of gold output for the year of $380,814, yet the oldest of the large fields, Oroville, Butte County, shows an increased output of $92,935. The gains or losses resolve themselves with these figures into a total deficit in the dredging industry of 1912 of $236,506, which is not marked considering the total output from this source of $7,429,955 in gold. Nor can it be considered as indicative of the beginning as yet of the predicted gradual decline of yield of the larger dredging fields of the State. The longer dredging machines are in use the less effective they are, for the reason that more time is lost in making repairs and keeping them in condition, as compared with new dredges. The larger dredges recently built are made with steel hulls, and have much more powerful digging machinery than the older dredges. They are generally of greater capacity and much more durable than the earlier type of dredge, numbers of which have been worn out and discarded. The yield of gold from each of the single dredges operating in Merced, Shasta, Siskiyou, and Stanislaus counties has been combined in the tables herewith in order to conceal individual output. In the State tabulations of output the figures of the yield of Shasta and Siskiyou county dredges have been deducted from the placer yield of those counties and combined with that of Merced and Stanislaus counties, each of which has only one producing property, and that a dredge. In the deep gold mines of the State, taken altogether, there was a decrease in tonnage of siliceous ore of 70,918 tons in 1912, yet the gold output from the 2,225,429 tons treated showed an increase of $453,965. Several of the old mines in the Mother Lode counties, which have been idle for 20 years or more, were reopened and unwatered in 1912; the shafts were repaired and retimbered, and operations to continue sinking were resumed. In some mines the old 1,000 or 1,500 foot shafts are to be sunk 1,000 or so feet more direct, to attain greater depth before stopping to make stations or to start new levels. The individuals or corporations doing this work are encouraged by the results accomplished by some of the larger Mother Lode properties in handling ores mined at depths below the 2,000 and 3,500 foot levels. A matter involving the future care of débris or tailings from quartz mines, affecting primarily certain Mother Lode mines in Amador County, has come up. An injunction suit involving several thousand acres of farming land in San Joaquin, Sacramento, and Amador counties was filed against eight large mines by the Valley Farm & Stock Co. and 26 other land owners. It was the charge of the landowners that the mining companies have allowed tailings and other débris to accumulate in Dry Creek to such an extent that the stream has frequently overflowed and inundated the surrounding territory. A compromise has been effected since the close of the year. By its terms the Kennedy, Zeila, Argonaut, South

Eureka, Central Eureka, Original Amador, Bunker Hill, and Fremont Consolidated mining companies are exempt from litigation until December, 1914. If by that time certain steps are taken to protect the property of the plaintiffs exemption is promised forever. The companies have arranged to restrain their tailings, as the hydraulic mines of certain portions have been compelled by law to do.

An attempt was made during 1912 to ascertain the condition of the industry of dry washing for gold in California, particularly in the semiarid and desert regions, but it was not as successful as hoped for. Most of the men working the dry placers are nomadic in their pursuits, and only go to the camps during the season when the weather is not too hot. These localities, too, are usually isolated—at points where there are no towns or communities.

There is some dry washing going on in the Summit and Goler districts, near Randsburg, Kern County, but those who control the properties are reticent as to results. Work of this kind is also being done about 12 miles southeast from Ricardo in the same county in Last Chance and Black Mountain camps, but no output has been reported there lately. Christmas camp, 24 miles north of Garden station, is being worked by dry washing. At Coolgardie camp, 20 miles north of Barstow, some gold from ancient river bed gravel was obtained by dry washing. There is a dry gold washing company which recently started operations 2 miles south of Randsburg, and which, it is reported, is meeting with some success. Some desultory work is being done in dry washing at a few places along Colorado River in Riverside and San Bernardino counties. The scattered claims are only worked occasionally. From the Bonanza and Deep Diggings mines, in Red Rock district, Kern County, some gold production is reported. The miners can not figure on any average yield per cubic yard, for the gold is found only in spots, and these are growing scarcer every day. Here, as at other places, the gravel wash or pay dirt lies at varying depths of 2 to 20 feet on the bedrock, and only the dirt close to the bedrock has gold enough to pay for working. Even then it is in spots only. There were formerly several makers of dry-washing machines in Los Angeles, but as far as known there is only one now, and no information could be elicited from him. He is making what he calls a "three-man machine," weighing about 50 pounds and costing $50. Most of the men working at this business make their own dry-washing machines. They are all "bellows" machines, in which a pulsating pressure of air is forced through canvas stretched on wire screen, blowing off the fine material on the canvas and leaving the gold and black sand to be subsequently panned. Wire screens are first used to take out the coarser gravel and refuse, before the partly concentrated material is placed on the canvas shaking table. The whole system is one of concentration by air. The total output of these dry placers amounts to but a few thousand dollars annually in California, because most of the operations are carried on by individuals in a small way.

A form of gold mining somewhat peculiar to the Pacific coast, and a source of gold production in California, is mining the heavy black sand of the ocean beaches, especially near the mouths of rivers draining areas which carry auriferous gravels. These beaches are worked

intermittently, more particularly after winter storms, when the overburden of ordinary beach sand has washed away, leaving the black and heavier sand behind. The sands are dug up and washed in "toms" or sluices, or are handled by concentrators. Additional interest has been taken lately in such of these beaches as yield platinum as a by-product of the gold. Three miles south of Crescent City, Humboldt County, the present beach is very wide and has long been known to carry values in gold and platinum. Repeated efforts to extract these values have previously met with failure. Within the last year, however, a large plant with an improved system of concentration has produced a considerable quantity of gold, platinum, and iridosmine, while working in the flat back of the sand dunes of the beach, where it is well protected from storms. Here a tract of more than 100 acres is said to yield an average of more than $1 per cubic yard from the surface to a depth of 15 feet, the greatest depth to which the mining has been carried.

Many beaches containing gold and platinum are known at several widely separated points on the California coast line, notably at Little River, Humboldt County, and at Aptos, Monterey County, Surf and Lompoc, Santa Barbara County, but no mining is in progress on them except some prospecting at Little River. For many years experiments have continued to be made to work these beach deposits on a large scale by various methods, but the business still remains one of small proportions as far as total annual product is concerned.

The condition of the copper-mining industry of the State has already been considered in some detail. The Bully Hill and the Balaklala smelters in Shasta County still continue inactive, but it is expected that they will again start operations during 1913. A Shasta County grand jury has condemned the great smelting plant of the Mammoth Copper Co. of Maine, at Kennett, as a nuisance, but it has not been closed, having spent large sums to prevent damage by smelter fumes. The higher price of copper in 1912, as compared with 1911, brought the values of the copper-mine product out at the end of the year with a considerable increase in total value, although the quantity of metal produced was much less than in 1911. Of the lead-mining industry in the State there is little to add to what has already been said, both quantity and value showing some decrease. No new mines of importance have been opened, and those formerly worked and being worked now have not increased their output but rather lessened it.

As a by-product of the gold placer mining in California in 1912 a recovery of 603 crude ounces of platinum, valued at $19,731, was made. In production of platinum California is the leading State, a small quantity coming annually from Oregon placers also, and another small quantity coming of recent years from copper mines of Wyoming. No other State produced platinum in the United States in 1912.

In the section on production by counties in this report the details of deep-mining work in the Mother Lode counties are given. A condensed statement of the record of these Mother Lode counties, including all deep mines in these counties, is given in the following table:

Tonnage of ore and value recovered in bullion in gold and silver mills, tonnage and value of concentrates produced, and total recovery, with average value per ton, in Mother Lode counties in California, 1912.

County.	Ore to gold and silver mills.				Concentrates produced.				Value of total recovery.	Value of total average recovery per ton.
	Quantity.	Gold in bullion.	Silver in bullion.	Average value in gold and silver recovered on plates per ton.	Quantity.	Gold.	Silver.	Average value in gold and silver per ton.		
	Short tons.		*Fine ounces.*		*Short tons.*		*Fine ounces.*			
Amador	673,498	$1,734,737	18,685	$2.59	13,985	$1,013,246	17,603	$73.22	$2,770,300	$4.11
Calaveras	371,568	350,675	4,597	.95	8,649	339,376	11,564	40.05	699,990	1.88
Eldorado	8,871	38,939	909	4.45	102	3,961	106	39.46	43,524	4.90
Mariposa	18,743	140,885	6,202	7.72	586	14,223	1,016	25.33	159,547	8.51
Tuolumne	227,308	814,431	34,011	3.67	7,974	291,024	6,832	37.03	1,130,574	4.97
Total	1,299,988	3,079,667	64,404	2.40	31,296	1,661,830	37,121	53.83	4,803,935	3.69

A comparison of this table with the corresponding one for the year 1911 shows a total decrease of tonnage milled in the five Mother Lode counties in 1912 of 77,096 tons of ore. Amador and Mariposa counties show increase of tonnage, but the other counties show decrease. The decrease in total gold and silver output was $94,559. The average value of gold and silver recovered on the plates in the mills in 1912 was 14 cents per ton more than in 1911, the average value of the gold and silver in the concentrates was $3.09 more per ton, and the average recovery was 12 cents per ton higher.

The quantity of ore treated from the deep mines of the State in 1912 was 2,641,497 tons, or 155,764 tons less than in 1911. Of the total tonnage 1,299,988 tons came from the Mother Lode counties, exclusive of copper ores smelted from Calaveras County, which are responsible for 77,096 tons of the total decrease of 155,764 tons. Amador County has the record for the largest output of tonnage of any county in the State, as well as the largest production of gold.

The total tonnage, by kinds of ore sold or treated in each county of California in 1912, is shown in the following table:

Subdivision of tonnage of crude ore sold or treated in California in 1912, by counties, in short tons.

County.	Siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Total ore.
Alpine	1,200	.....	.....	.....	1,200
Amador	736,271	877	.....	.....	737,148
Butte	3,326	.....	.....	.....	3,326
Calaveras	374,775	55,353	.....	.....	430,128
Eldorado	8,871	.....	.....	.....	8,871
Fresno	603	.....	.....	.....	603
Humboldt	50	.....	.....	.....	50
Inyo	63,184	55	904	6,472	70,615
Kern	168,197	6	23	.....	168,226
Los Angeles	457	.....	.....	.....	457
Madera	624	956	.....	.....	1,580
Mariposa	18,748	2,346	.....	.....	21,094
Modoc	2,171	.....	.....	.....	2,171
Mono	32,324	28	47	.....	32,399
Monterey	267	.....	.....	.....	267
Nevada	270,148	.....	.....	.....	270,148
Placer	27,104	625	.....	.....	27,729
Plumas	27,368	30	.....	.....	27,398
Riverside	1,645	.....	.....	.....	1,645
San Bernardino	44,663	59	.....	.....	44,722
Shasta	66,829	348,287	.....	.....	415,116
Sierra	76,606	.....	.....	.....	76,606
Siskiyou	13,160	.....	.....	.....	13,160
Trinity	57,307	.....	.....	.....	57,307
Tuolumne	228,823	.....	.....	.....	228,823
Yuba	708	.....	.....	.....	708
Total	2,225,429	408,622	974	6,472	2,641,497
Increase (+) or decrease (−)	−70,918	−85,659	−1,034	+1,847	−155,764
Average value per ton in gold and silver	$4.95	$1.91	$24.18	$2.59	$4.49

Total yield and average value per ton in gold and silver and in all metals, of the different classes of ore mined and treated in California, in 1912.

Class of ore.	Tonnage.	Total value of gold and silver.	Total value in all metals.	Average value of gold and silver.	Average value in all metals.
	Short tons.			*Per ton.*	*Per ton.*
Siliceous	2,225,429	$11,023,831	$11,411,367	$4.95	$5.13
Copper	408,622	781,299	5,975,672	1.91	14.62
Lead	974	23,545	49,498	24.18	50.82
Zinc	6,472	16,798	279,820	2.59	43.23
Total	2,641,497	11,845,473	17,716,357	4.49	6.71

The subdivision of tonnage and production of gold and silver in California in 1912, according to methods of treatment, is shown in the table following:

Subdivision of tonnage and production of gold and silver in California in 1912, according to methods of treatment, by counties.

County.	Ore to gold and silver mills.			Concentrates produced.		
	Tonnage.	Gold.	Silver.	Tonnage.	Gold.	Silver.
			Fine ounces.			*Fine ounces.*
Alpine	800			17	$1,364	2,300
Amador	673,498	$1,734,737	18,685	13,985	1,013,246	17,603
Butte	3,165	20,178	172	1	89	18
Calaveras	371,568	350,675	4,597	8,649	339,376	11,564
Eldorado	8,871	38,939	909	102	3,961	106
Fresno	603	6,094	37			
Humboldt	50	300	16			
Inyo	54,097	332,162	14,559	1,176	544	18
Kern	164,612	807,896	11,928	10	62	7
Los Angeles	457	3,236	64			
Madera	624	7,210	896	10	1,785	215
Mariposa	18,743	140,885	6,202	586	14,223	1,016
Modoc	2,145	23,624	667			
Mono	15,400	359,736	100,291			
Monterey	267	3,296	36			
Nevada	270,134	1,927,294	25,880	4,073	108,949	10,829
Placer	27,104	103,677	4,813	320	15,047	1,104
Plumas	27,368	100,805	628	435	8,477	499
Riverside	1,579	19,559	400			
San Bernardino	3,899	15,394	1,670	270	91	6,146
Shasta	66,470	664,526	5,876	372	37,024	852
Sierra	75,206	613,155	3,506	105	1,762	358
Siskiyou	11,160	182,211	2,437	263	6,059	145
Trinity	51,464	243,553	9,138	25	2,035	174
Tuolumne	227,308	814,431	34,011	7,974	291,024	6,832
Yuba	708	12,656	102			
Total	2,077,300	8,526,229	247,520	38,373	1,845,118	59,786
Average value per ton		$4.10	$0.07		$48.08	$0.96

County.	Crude ore to smelter.			Old tailings treated.		
	Tonnage.	Gold.	Silver.	Tonnage.	Gold.	Silver.
			Fine ounces.			*Fine ounces.*
Alpine				400	$400	
Amador	877	$10,670	15,036	62,773	22,813	624
Butte	161	1,034	17			
Calaveras	55,357	55,174	97,836	3,203	3,286	50
Inyo	7,856	13,106	57,906	8,662	23,946	1,202
Kern	193	2,122	6,717	3,421	17,670	
Madera	956	167	779			
Mariposa	2,351	2,267	3,800			
Modoc	21	4,214	136	5	55	
Mono	75	858	14,509	16,924	16,924	
Nevada	14	599	29			
Placer	625	4,039	403			
Plumas	30		32			
Riverside	66	643	13			
San Bernardino	39,823	274,645	73,371	1,000	3,010	48
Shasta	348,319	221,050	684,382	327	442	100
Sierra				1,400	1,568	14
Siskiyou				2,000	2,200	
Trinity	11	1,944	101	5,832	9,825	65
Tuolumne				1,515	1,797	8
Total	456,735	592,532	955,067	107,462	103,936	2,111
Average per ton		$1.30	$1.29		$0.96	$0.01

Average recovery per ton from bullion and concentrates: Gold, $4.99; silver, $0.08.

Reports were received from 1,041 producing mines in California in 1912, as shown in the following table:

Number of producing mines in California, classified by chief product in 1912, by counties.

Year.	Placer mines.					Deep mines.						Total mines reporting product.
	Hydraulic.	Dredging.	Drift.	Surface.	Total.	Gold.	Copper.	Silver.	Silver-lead and zinc.	Zinc.	Total.	
Alpine						1					1	1
Amador	1		6	4	11	30	3				33	44
Butte	3	28	19	18	68	9					9	77
Calaveras	3	3	11	14	31	37	2				39	70
Del Norte	3			5	8							8
Eldorado	1		21	11	33	18					18	51
Fresno						3					3	3
Humboldt	12			2	14	1					1	15
Inyo						30	2	4	14	1	51	51
Kern				3	3	37	1	2	1		41	44
Los Angeles						3					3	3
Madera						4	2				6	6
Mariposa			1	5	6	28	4				32	38
Merced		1			1							1
Modoc						7					7	7
Mono						8	2		5		15	15
Monterey				1	1	3					3	4
Nevada	2		7	4	13	31					31	44
Placer	6	3	33	12	54	10	1				11	65
Plumas	8		14	23	45	21	1				22	67
Riverside						7					7	7
Sacramento		11	4		15							15
San Bernardino				1	1	16	3	4	5		28	29
San Luis Obispo				3	3							3
Shasta		1	2	6	9	25	3	2			30	39
Sierra	10		13	6	29	25					25	54
Siskiyou	51	1	6	17	75	37					37	112
Stanislaus		1			1							1
Trinity	41	2	4	12	59	26					26	85
Tuolumne			4		4	49					49	53
Yuba		14	1	10	25	4					4	29
Total	141	65	146	157	509	470	24	12	25	1	532	1,041

REDUCTION MILLS IN CALIFORNIA IN 1912.

An investigation was made in 1912 as to the number of reduction mills in California, with details of their equipment. A condensed statement of the result of this inquiry is shown as follows:

Total number of reduction mills in California in 1912.

Mills.	Number of plants.	Crushers.	Number of stamps.	Roller mills.	Tube mills.	Concentrators.	Cyanide plants.	Capacity in 24 hours.
								Short tons.
Active mills	190	145	2,963	21	3	752	30	12,267
Inactive mills	293	145	3,057	33	2	582	26	12,114
Total	483	290	6,020	54	5	1,334	56	24,381

The number of idle mills in the State, as shown, exceeds that of the active ones. However, in number of stamps there is very little difference between active and inactive plants, and the daily capacity in short tons is slightly higher in the case of the active mills. It is evident, also, that in many places reduction works were provided

before mine developments warranted them, and this is particularly marked in certain extensive properties now with large idle mills in consequence of lack of sufficient ore to keep them busy. In other places the ore was not of grade high enough to make its milling profitable. But most of the idle mills are old ones, built years ago, now partly or entirely worn out, and not suitable for handling ores in properties where the margin of profit in milling is very small. On some properties litigation or mismanagement has caused the closing down of mills temporarily, and on others the ore was too poor to warrant milling under any circumstances.

The following list gives the reduction mills in California in 1912:

Reduction mills in California in 1912, by counties.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
ALPINE COUNTY.				*Short tons.*
Curtz [a]	Markleeville	Amalgamation, concentration.	1 crusher, 16 stamps, 1 Johnson concentrator, 16 Frue vanners.	80
Nevada Hercules	do	Concentration	1 Blake crusher, 20 stamps, 1 Pinder concentrator, 8 Frue vanners, 1 Wilfley concentrator.	80
AMADOR COUNTY.				
Bunker Hill	Amador City	Amalgamation, concentration.	1 Blake crusher, 40 stamps, 24 Frue vanners.	203
Keystone	do	do	1 Gates crusher, 60 stamps, 24 vanners.	300
Original Amador	do	do	1 crusher, 20 stamps, 1 vanner, 1 Deister concentrator.	100
South Spring Hill [a b]	do	do	2 Blake crushers, 40 stamps, 14 Frue vanners.	140
Marchand [a]	Defender	Amalgamation	5 stamps	10
Fremont	Drytown	Amalgamation, concentration.	2 crushers, 40 stamps, 16 Frue vanners.	200
Pocahontas	do	do	10 stamps, 2 Frue vanners.	40
Ione Copper	Ione	do	1 Blake crusher, 4 quadruple discharge, 1,650-pound stamps, 1 Frue vanner, 3 Pinder tables.	40
Argonaut	Jackson	do	1 crusher (Knight), 40 stamps, 10 Frue vanners, canvas tables.	200
Clinton [a]	do	do	1 crusher, 30 stamps, 12 Frue vanners.	100
Hardenberg	do	do	20 stamps, 8 Frue vanners. Started up February, 1913.	100
Kennedy	do	Amalgamation, concentration, chlorination.	1 Blake crusher, 100 stamps, 40 Frue vanners, canvas slime plant, 76 Gates canvas tables, chlorination plant.	500
Jose Gulch	do	Amalgamation	10 stamps	40
Oneida [a]	do	Amalgamation, concentration.	1 Gates crusher 60 stamps, 26 Frue vanners.	300
Zeila	do	do	1 crusher, 40 stamps, 16 Frue vanners.	200
Gold King [a]	Pine Grove	Amalgamation	10 stamps	40
A. & B. [a]	Plymouth	do	2 stamps	8
Rhetta [a]	do	do	10 stamps	40

[a] Idle in 1912. [b] Destroyed by fire January, 1913.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
AMADOR COUNTY—continued.				
				Short tons.
Burlington [a]	Sutter Creek	Amalgamation, concentration.	Knight crusher, 6-stamp Hendy mill, 2 Frue vanners.	30
Central Eureka	do	do	1 Blake crusher, 40 stamps, 16 Frue vanners.	200
East Eureka	do	do	1 crusher, 20 stamps, 8 Gates concentrators.	100
South Eureka	do	do	1 Blake crusher, 80 stamps, 48 Frue vanners.	400
Lincoln [a]	do	do	2 crushers, 2 40-stamp mills, 32 Frue vanners.	300
BUTTE COUNTY.				
Crystal Peak	Enterprise	Amalgamation, concentration.	10 stamps, 1 standard concentrator.	40
Edel [a]	do	do	1 crusher, 4 stamps, 2 Frue vanners.	20
St. Francis [a]	do	Amalgamation	1 Dodge crusher, Muller mill.	20
Carlisle [a]	Forbestown	Amalgamation, concentration.	1 Dodge crusher, 10 stamps, 2 Johnson concentrators.	35
Garibaldi [a]	do	do	5 stamps	20
Gold Bank [a]	do	Amalgamation, concentration, cyanidation.	1 Gates crusher, 20 stamps, 2 Trent machines for cyanidation.	75
Green Mountain [a]	Inskip	Amalgamation	10 stamps	40
Gold Bug	Lumpkin	do	2 stamps	5
Williams	do	do	1 Dodge crusher, 2-stamp Hendy mill discharging into 10-ton Beers roller mill.	15
CALAVERAS COUNTY.				
Jim Lee [a]	Altaville	Amalgamation	10 stamps	40
Angels Quartz	Angels Camp	Amalgamation, concentration.	1 Blake crusher, 40 stamps, 16 Frue vanners.	200
Benson [a]	do	do	10 stamps	40
Bovee-Fritz [a]	do	do	5 stamps	20
Smyth	do	do	1 Kendall crusher, 10 stamps, 4 Gates concentrators.	35
Dolling	do	do	1 Blake crusher, 40 stamps, 16 Frue vanners.	200
Etna King [a]	do	do	1 crusher, 10 stamps, 4 Frue vanners, 2 concentrators.	40
Hardy-McCreight [a]	do	Amalgamation	5 stamps	20
Lightner	do	Amalgamation, concentration.	60 stamps, 36 Frue vanners.	300
Economic [a]	do	do	1 crusher, 20 stamps, 8 Frue vanners.	100
Utica	do	do	2 mills total 100 stamps, 2 Sturtevant crushers, 59 Frue vanners.	500
Ingomar [a]	Campo Seco	do	1 crusher, 10 stamps, 2 Woodbury concentrators.	30
Mountain King [a]	Copperopolis	Amalgamation	10 stamps	40
Wilbur Womble	do	do	15 stamps	55
Finnegan	Carson Hill	do	10 stamps	40
Royal Consolidated [a]	Hodson	Amalgamation, concentration, chlorination.	3 Gates crushers, 120 stamps, 24 Standard concentrators, 6 Wilfleys, 6 Johnson, 2 agitation tanks, 2 filters.	700
Gwin [a]	Gwinmine	Amalgamation, concentration.	1 Blake crusher, 100 stamps, 40 Union concentrators.	500
Matson	Glencoe	Amalgamation	5 stamps	6
Rockingham [a]	do	do	do	15

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
CALAVERAS COUNTY—continued.				*Short tons.*
Plymouth Rock [a]	Jenny Lind	Amalgamation, concentration.	1 Comet crusher, 10 stamps. 18 Frue & Tulloch vanners.	60
Alto [a]	do	do	1 Blake crusher, 40 stamps, 16 Tulloch concentrators.	160
Melones	Melones	do	2 gyratory crushers, 100 stamps, 4 Spitzkasten classifiers, 22 Frue vanners, 21 Wilfley tables.	500
Red Top	Mitchell Mills	Amalgamation	5 stamps	10
Del Monte Goldfields [a]	Mokelumne Hill	Amalgamation, concentration.	12 stamps, 6 Frue vanners.	45
Guiffra [a]	do	Amalgamation	10 stamps	40
Hamby	do	Amalgamation, concentration.	1 crusher, 20 stamps, 4 Frue vanners.	100
Quartz Glen	do	do	10 stamps, 2 vanners	30
Greek [a]	do	do	1 Dodge crusher, 5 stamps, 1 Frue vanner.	20
Big Ben [a]	do	do	4 stamps, 1 Tulloch concentrator.	16
Mechanics [a]	Mountain Ranch	Amalgamation	1 crusher, 5 stamps	15
Montana [a]	do	do	2 stamps	6
Clary [a]	Sheep Ranch	Amalgamation, concentration.	1 crusher, 10 stamps, 4 Frue vanners.	50
Hercules [a]	Murphy	do	1 Dodge crusher, 2 stamps, 1 Standard concentrator.	6
Comet	Railroad Flat	do	1 crusher, 10 stamps, 1 Frue vanner, 1 Diester concentrator.	25
American Eagle [a]	do	Amalgamation	12 stamps	10
Swiss [a]	do	Amalgamation, concentration.	1 crusher, 10 stamps, 2 Johnson concentrators.	31
Pickering [a]	do	Amalgamation	4 stamps	6
Sheep Ranch	Sheep Ranch	Amalgamation, cyanidation.	20 stamps, 4 cyanide, 4 percolation tanks.	60
Duchess [a]	Vallecita	Amalgamation	10 stamps	40
Rowe & Jenkins [a]	Westpoint	do	5 stamps, 1 Frue vanner	5
Hidden Cave [a]	do	do	1 Blake crusher, 3 stamps.	10
North Star [a]	do	do	5 stamps	15
Thompson [a]	do	do	do	5
ELDORADO COUNTY.				
Good Luck	Diamond Springs	Amalgamation	5 stamps	15
Crusader [a]	Eldorado	do	10 stamps	40
Union	do	Amalgamation, concentration.	1 crusher, 20 stamps, 8 Frue vanners.	60
Davis & Moyer	do	Amalgamation	4 stamps	8
Hillside [a]	do	do	5 stamps	20
Mayflower [a]	do	do	1 drop stamp	2
Nashville	do	Amalgamation, concentration.	2 stamps, 1 Frue vanner	6
Blue Bird [a]	Georgetown	Amalgamation	10 stamps	50
Gilbert [a]	Greenwood	do	do	50
Golden Spike [a]	Grizzly Flats	do	5 stamps	20
Mount Pleasant [a]	do	Amalgamation, concentration.	10 stamps, 4 Frue vanners	40
Mount Hope [a]	do	Amalgamation, concentration, cyanidation, chlorination.	10 stamps, 1 Woodbury concentrator.	25
Last Chance [a]	Nashville	Amalgamation, concentration.	1 crusher, 10 stamps, 2 Standard concentrators.	40
Montezuma [a]	do	do	10 stamps, 2 Wilfley tables.	22
Stillwagon [a]	Omo Ranch	do	1 Gates crusher, 5 stamps, 1 Wilfley concentrator.	20
Richmond	do	do	4 stamps, 1 Wilfley concentrator.	12
Ingram [a]	Pilot Hill	do	5 stamps, 1 Woodbury concentrator, special design riffle boxes.	10

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
ELDORADO COUNTY—continued.				*Short tons.*
Toadstool [a]	Placerville	Amalgamation, concentration.	Chilean roller mill	15
Grand Victory [a]	do	do	1 Blake crusher, 10 stamps, 8 Frue vanners.	80
Poverty Point	do	do	1 Dodge crusher, 15 stamps, 2 Frue vanners, 3 Wilfley tables.	60
Larkin [a]	do	Amalgamation	10 stamps	40
1 to 16 [a]	do	do	2 stamps	7
Sherman [a]	do	Amalgamation, concentration.	1 Blake crusher, 10 stamps 2 Wilfley tables, 1 Woodbury table, 2 Frue vanners.	40
California & Ohio [a]	Shingle	Amalgamation	12 stamps	8
Big Canyon [a]	do	Amalgamation, concentration, chlorination.	McCully gyratory crusher, 30 stamps, 24 Tulloch and Triumph vanners.	80
Pyramid [a]	do	Amalgamation	15 stamps	60
Red Raven [a]	do	do	10 stamps	40
Gopher Boulder [a]	Slatington	do	20 stamps	80
Alverado [a]	Smith Flat	do	Revolving barrel, gravel mill, and shaking tables.	125
Kumfa-Carpender [a]	do	do	15 stamps	60
FRESNO COUNTY.				
Davis Flat [a]	Dunlap	Amalgamation, concentration.	1 crusher, 5 stamps, 1 Johnson concentrator.	24
Blue Canyon [a]	Ockenden	do	1 Huntington mill, 3 cyanide tanks.	20
Laurel Hill [a]	do	Amalgamation	1 stamp mill	5
Richter [a]	do	Amalgamation, concentration, cyanidation.	2 stamps, 1 Frue vanner, 10-ton cyanide tanks.	3
Graveyard	Pineridge	Amalgamation, concentration.	10-ton Kincaid mill, 1 Woodbury concentrator.	10
Eliza Jane	Trimmer	Amalgamation, cyanidation.	1 Dodge crusher, 5 stamps, 5 cyanide tanks.	25
HUMBOLDT COUNTY.				
Horse Mountain	Korbel	Concentration	1 Blake crusher, 1 Dodge crusher, 2 Huntington mills, classifiers, 1 Standard concentrator, 1 United table.	50
Doney [a]	Orleans	Amalgamation	2 stamps	4
Red Cap [a]	do	do	do	10
IMPERIAL COUNTY.				
American Girl [a]	Ogilby	Amalgamation, concentration, cyanidation.	Roller mill, 1 concentrator, cyanide tanks.	20
Tumco [a]	Tumco	Amalgamation, cyanidation.	1 Gates crusher, 100 stamps, one 5 by 22 tube mill, 2 Akin classifiers, 1 Dorr thickener, 3 Trent agitators.	350
Picacho Basin [a]	Picacho	Cyanidation	2 Cornish rolls	200
INYO COUNTY.				
Arondo	Searles	Amalgamation, cyanidation.	2 crushers, rolls, 85-ton cyanide vats.	80
Golden Rod [a]	Ballarat	do	1 Blake crusher, 5-stamp mill, two 20-ton cyanide tanks.	20
Redlands [a]	do	do	1 crusher, 10 stamps, 6 cyanidation tanks, 2 percolation tanks.	35
Wilshire Bishop Creek [a]	Bishop	Amalgamation	1 Traylor crusher, 10 stamps, 3 grinding pans.	50

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
INYO COUNTY—contd.				*Short tons.*
Blue Bell [a]	Darwin	Amalgamation	5 stamps	20
California [a]	do	do	do	20
John C. Cress	do	Amalgamation, concentration.	1 crusher, 5 stamps, 1 Wilfley concentrator.	10
Inyo Coso [a]	do	Amalgamation	2-stamp mill	8
Reward	Independence	Amalgamation, concentration.	1 crusher, 20 stamps, 2 Frue vanners, 3 Dodd, 2 Wilfley, 2 Diester tables.	60
Southern Belle [a]	Laws	Amalgamation	10 stamps	40
Best [a]	Skidoo	Amalgamation and concentration.	1 crusher, rotary mill, 1 vanner.	20
Skidoo [a b]	do	Amalgamation, concentration, cyanidation.	2 Blake crushers, 15 stamps, 3 Standard concentrators, 60-ton cyanide plant.	50
John Cyty [a]	Keane Wonder	Amalgamation	1 crusher, 3 stamps	18
Keane Wonder	do	Amalgamation cyanidation.	1 crusher, 20 stamps, 6 cyanide tanks, 6 percolation tanks.	80
KERN COUNTY.				
Providence	Amalie	Amalgamation, concentration, cyanidation.	Huntington mills, 2 concentrators, 4 cyanide tanks.	10
Star of West	Brown	do	1 Blake crusher, 5 stamps, 1 Wilfley table, 5 cyanide tanks, 5 percolation tanks.	12
Zada [a]	Amalie	Amalgamation, cyanidation.	10-stamp mill, cyanide plant.	40
Glen Olive	Bodfish	Amalgamation	1 crusher, 10 stamps	30
Portuguese	do	Amalgamation, concentration.	1 Blake crusher, 5 stamps, 1 Johnson concentrator.	18
White Star [a]	do	Amalgamation	2 stamps	4
King Solomon	Havilah	do	5 stamps	20
Warrington [a]	do	Amalgamation, concentration, cyanidation.	1 Blake crusher, 10 stamps, 2 Johnson concentrators, 7 cyanidation tanks, Wood percolation tanks, 1 agitation tank.	20
Mammoth	Isabella	Amalgamation, concentration.	10 stamps, 1 Wilfley concentrator.	40
Mammoth Mountain	do	do	1 Hercules crusher, 10 stamps, 1 Standard concentrator.	20
Alfie Springs [a]	Mohave	do	2 sets Cornish rolls, end-bump concentration tables.	5
Exposed Treasure [a]	do	Amalgamation, concentration, cyanidation.	2 Blake crushers, 30 stamps, 8 Wilfley concentrators, 13 cyanide tanks, 9 percolation tanks, 4 air-agitation filters.	125
Karma-Ajax [a]	do	Amalgamation	25 stamps	100
Grouse Meadow	Loraine	do	4 stamps	8
Zenda [a]	do	Amalgamation, concentration, cyanidation.	2 crushers, 10 stamps, 1 Dorr classifier, 3 Bartlett concentrators, 8 cyanide tanks.	50
Bowman [a]	Piute	Amalgamation, concentration.	1 crusher, 3 stamps, 2 Johnson concentrators.	3
Baltic [a]	Randsburg	Amalgamation, cyanidation.	1 Blake crusher, 10 stamps, four 50-ton cyanide tanks, and percolation tanks.	50
Good Hope	do	Amalgamation	5 stamps	25
Little Butte [a]	do	do	2 stamps	4
Phoenix	do	do	1 crusher, 5 stamps, 1 heavy stamp.	25

[a] Idle in 1912. [b] Burned in 1913.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
KERN COUNTY—contd.				*Short tons.*
Red Dog	Randsburg	Amalgamation, concentration, cyanidation.	1 Blake crusher, 10 stamps, 1 Standard concentrator, cyanide plant.	30
Sunshine	do	Amalgamation, cyanidation.	1 crusher, 3 stamps, cyanide plant.	10
Yellow Aster	do	Amalgamation	2 crushers, 2 mills, 100 stamps, 30 stamps.	500
Black Cat [a]	Rosamond	Amalgamation, cyanidation.	1 crusher, 10 stamps, 5 cyanide tanks.	20
Fairview [a]	do	do	10 stamps, cyanide plant.	35
Milwaukee [a]	do	Amalgamation	10 stamps	50
Antelope Valley	do	Amalgamation, cyanidation.	1 crusher, 5 stamps, 6 cyanide tanks, 2 agitation tanks.	15
Tropico [a]	do	do	1 Blake crusher, 10 stamps, cyanide plant.	30
Grizzly [a]	White River	Amalgamation, concentration.	5 stamps, concentrator	20
White River [a]	do	Amalgamation	5 stamps	15
Blue Mountain [a]	do	Amalgamation, concentration.	4 Gates crusher, 5 stamps, 1 Johnson concentrator.	15
Francis [a]	Weldon	do	5 stamps	15
Pine Mountain [a]	Woody	do	5 stamps, 1 Johnson concentrator.	15
Saginaw [a]	do	Amalgamation	Huntington mill	10
LASSEN COUNTY.				
Golden Eagle [a]	Hayden Hill	Dry crushing, cyanidation.	2 Krom rolls, 12 50-ton cyanide tanks.	100
Hayden Hill [a]	do	Amalgamation	10 stamps	40
LOS ANGELES COUNTY.				
Red Rover	Acton	Amalgamation, cyanidation.	1 Dodge crusher, 10 stamps, Cone classifiers, 5 cyanide tanks, 3 25-ton percolation tanks.	24
Native Son [a]	Cajon	do	Hendy crusher, 3 stamps, 1 Pinder concentrator.	18
Collins	Neenach	Amalgamation	5 stamps	8
MADERA COUNTY.				
Waterloo [a]	Coarse Gold	Amalgamation, concentration, cyanidation.	1 Blake crusher, 10 stamps, 4 Wilfley concentrators.	50
Pure Gold [a]	do	Amalgamation	5 stamps	25
Texas Flat [a]	do	Amalgamation, concentration.	20 stamps, 4 Wilfley concentrators.	80
Moonlight [a]	Grub Gulch	Amalgamation	1 crusher, Huntington mill.	12
Gambetta	do	Amalgamation concentration.	1 crusher, 2 Huntington mills, 2 Diester concentrators.	40
Rex [a]	do	Amalgamation	1 crusher, 2 stamps	10
Gold Gem [a]	Hildreth	do	2 stamps	8
Contention [a]	O'Neals	Amalgamation, concentration.	24-ton Bryan mill, 1 Frue vanner.	20
Mud Springs [a]	do	do	Huntington mill, 2 Frue vanners.	12
A. B. Smith	do	Amalgamation	5 stamps	20
Europa [a]	Raymond	Amalgamation, concentration.	2-stamp Hendy mill, 1 concentrator.	10
MARIPOSA COUNTY.				
King Solomon [a]	Briceburg	Amalgamation	1 Huntington mill, 4 stamps.	10
Crown Lead	Bagby	do	20 stamps	100
River Mill	do	Amalgamation, concentration.	1 Dodge crusher, 5 stamps, 2 Union concentrators.	25
Bondurant [a]	Coulterville	do	1 crusher, 10 stamps, 2 Union concentrators.	25

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
MARIPOSA COUNTY—continued.				*Short tons.*
North Fork[a]	Coultervllle	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 2 Frue vanners.	40
Mammoth[a]	do	Amalgamation	Krough mill	10
Merced[a]	do	do	40 stamps	100
Oro Rico	do	Amalgamation, concentration.	1 Blake crusher, 20 stamps, 2 Diester concentrators.	75
Tyro[a]	do	Amalgamation	10 stamps	30
Virginia[a]	do	do	1 Blake crusher, 10 stamps.	30
Original	El Portal	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 3 Pacific vanners.	30
Hite	do	do	20 stamps, 2 Frue vanners	40
Mount Gaines[a]	Hornitos	Amalgamation	10 stamps	40
Ruth Pierce[a]	do	do	do	40
Number One	do	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 2 Gates concentrators.	30
Comet[a]	Jerseydale	do	1 crusher, 10 stamps, 2 Diester slime tables.	30
Sweetwater	do	do	1 crusher, 10 stamps, 2 concentrators.	40
Carrie Todd	Kingsley	Amalgamation	1 stamp	5
Happy Home[a]	do	do	4 stamps	6
Trujillo	do	do	2 stamps	6
Francis[a]	Lewis	do	10 stamps	40
Austin	Mariposa	Amalgamation, concentration.	1 crusher, 10 stamps, 1 Pinder concentrator.	30
Mariposa	do	Amalgamation	1 Blake crusher, 5 stamps.	25
Princeton	Mount Bullion	Amalgamation, concentration.	2 Blake crushers, 40 stamps, 4 Union concentrators.	100
Mountain King	Mountain King	do	4 Nissen stamps, 30 stamps, 6 Johnson and 3 Standard concentrators.	136
Mountain Belle[a]	Mount Bullion	do	5 stamps, 1 concentrator.	20
Farmers Hope[a]	Whitlock	do	1 Dodge crusher, 5 stamps, 1 Frue vanner.	12
MODOC COUNTY.				
Keegel-Harvey	Canby	Amalgamation, cyanidation.	1 crusher, 10 stamps, hydraulic classifiers, 5 iron cyanide tanks, 1 agitation tank, 5 percolation tanks.	20
Big Four	Fort Bidwell	Amalgamation	15 stamps	45
Consolidated Mines	do	do	10 stamps	40
Sunset	do	do	Lane mill	40
MONO COUNTY.				
Rose of West[a]	Benton	Amalgamation	2 stamps	6
Sierra[a]	Bishop	do	10 stamps	40
New Bodie	Bodie	do	15 stamps	40
South End[a]	do	Amalgamation, cyanidation.	15 stamps, 12 cynide tanks, 6 percolation tanks.	30
Standard	do	do	1 crusher, 20 stamps, 1 tube mill, inside and outside amalgamation. Ore reground in tube mill with old tailings and cyanided, 12 cyanide tanks, 10 agitation tanks, Butters filters.	150
Monte Cristo[a]	Bridgeport	Amalgamation, concentration, cyanidation.	Blake crusher, 8 stamps, 1 Woodbury concentrator, 1 box classifier, 3 leaching tanks.	24
Golden Gate	Colville	Amalgamation	1 Hercules crusher, 10 stamps.	40

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
MONO COUNTY—contd.				*Short tons.*
Crystal Lake [a]	Lundy	Amalgamation, concentration.	1 crusher, 20 stamps, 8 Frue vanners.	60
Pittsburgh-Liberty	Sweetwater, Nev	Amalgamation, cyanidation.	1 Dodge crusher, 10 stamps, homemade classifier, 3 cyanide tanks, 3 Pachuca agitation tanks, 1 Oliver filter.	50
Columbia [a]	do	Amalgamation	10 stamps	40
NEVADA COUNTY.				
Golden State [a]	Chicago Park	Amalgamation, concentration.	4 stamps, 1 Frue vanner	7
Numitor [a]	Colfax	do	1 crusher, 15 stamps, Gates concentrator.	40
El Oro [a]	Gaston	Amalgamation	5 stamps	15
Erie	do	Amalgamation, concentration.	1 Blake crusher, 20 stamps, 3 Wilfley and 1 Frue concentrators.	100
Gaston	do	do	1 Blake crusher, 40 stamps, 4 Wilfley tables.	120
Annie [a]	Graniteville	Amalgamation	10 stamps	40
Ancho	do	do	1 Blake crusher, 10 stamps.	25
Staub [a]	do	do	1 Jones breaker, 14 stamps.	30
Dillon [a]	do	do	4 stamps	8
Republic	do	do	1 Blake crusher, 10 stamps.	35
Brunswick	Grass Valley	Amalgamation, concentration.	1 crusher, 20 stamps, 4 Johnson concentrators.	60
Bullion [a]	do	Amalgamation	10 stamps	20
Central Consolidated	do	Amalgamation, concentration.	1 crusher, 20 stamps, 4 Johnson concentrators, canvas plant.	45
Empire	do	Amalgamation, concentration, cyanidation.	1 Gates crusher, 40 stamps, 1 tube mill, 16 Frue vanners, 4 Merrill classifiers, 12 ore tanks, 4 percolation tanks, 4 agitation tanks, 1 Oliver filter.	135
Golden Gate	do	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 1 Frue vanner, 1 Johnson concentrator, canvas plant.	30
Idaho-Maryland	do	do	2 crushers, 20 stamps, 8 Frue vanners, 2 Johnson concentrators.	60
Jenny Lind [a]	do	Amalgamation	20 stamps for crushing gravel.	80
Kenosha [a]	do	Amalgamation, concentration.	1 Blake crusher, 5 stamps, 2 Frue vanners.	8
Niagara [a]	do	do	15 stamps, 3 Johnson concentrators.	45
North Star	do	Amalgamation, concentration, cyanidation.	2 Blake crushers, 40 stamps (inside and outside amalgamation), 1 tube mill, 4 Merrill classifiers, 9 Dodd buddles, 6 wooden percolation tanks, 3 agitation tanks, 2 Oliver filters (tailings to sand and slime cyanide plant; concentrates to tube mill and slime plant).	140

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
NEVADA COUNTY—con.				*Short tons.*
Central Consolidated	Grass Valley	Amalgamation, concentration, cyanidation.	2 Blake crushers, 40 stamps, 3 Merrill classifiers, 9 Dodd buddles, 6 wooden percolation tanks, 4 agitation tanks, 2 Oliver filters (owned and operated by North Star Co. on same system as North Star mill).	150
Prudential	do	Amalgamation, concentration.	1 Merrill crusher, Merrill classifier, 12-stamp mill, 6 Frue vanners, 4 Woodbury tables.	40
Pennsylvania	do	Amalgamation, concentration, cyanidation.	2 Blake crushers, 20 stamps, 2 Merrill classifiers, 4 Union concentrators, 4 cyanide tanks, 4 percolation tanks, 3 Pachuca agitators, 1 Oliver filter. (Mill owned by Empire Mines & Investment Co., same place.)	
Rough and Ready	do	Amalgamation, concentration.	2 stamps, 1 Johnson vanner.	5
Prescott	do	do	20 stamps, 4 Frue vanners.	55
Sunflower [a]	do	do	5 stamps, standard concentrator.	15
Union Hill [a]	do	do	2 Dodge crushers, 20 stamps, 4 Frue vanners.	80
Yuba Consolidated [a]	Maybert	do	2 Dodge crushers, 20 stamps, 1 Wilfley table.	75
Excelsior [a]	Meadow Lake	do	3 crushers, 10 stamps, 2 Johnson and 1 Wilfley concentrators.	30
Iron King [a]	do	Amalgamation	10 stamps	30
Montana	Nevada City	Amalgamation, concentration.	1 crusher, 5 stamps, 1 Johnson concentrator.	10
Buckeye [a]	do	do	5 stamps, 1 vanner	15
Cold Springs [a]	do	Amalgamation	10 stamps	30
Champion	do	Amalgamation, concentration, cyanidation.	2 crushers, 40 stamps, Frue vanners, cyanide plant.	160
Home [a]	do	Amalgamation, concentration.	1 crusher, 30 stamps, Frue vanners.	120
Providence [a]	do	do	2 crushers, 40 stamps, Frue vanners.	160
Lecompton [a]	do	do	10 stamps, 2 Frue vanners, 1 Johnson concentrator.	25
Mayflower [a]	do	do	1 crusher, 20 stamps 4 Frue vanners.	80
Mountaineer [a]	do	do	1 crusher, 10 stamps, 8 Frue vanners.	40
Murchie [a]	do	do	1 Blake crusher, 20 stamps, 4 Union concentrators, 4 Frue vanners.	100
Midas [a]	do	Amalgamation	4 stamps, (light)	3
Native Son [a]	do	do	5 stamps	20
Nevada Grass Valley	do	do	do	20
Texas [a]	do	Amalgamation, concentration cyanidation.	1 crusher, 5 stamps, 1 Frue vanner, 1 cyanide tank.	20
Oustomah [a]	do	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 6 Johnson concentrators.	40
Pittsburgh	do	do	2 crushers, 20 stamps, 6 Frue vanners.	40
Red Ledge [a]	do	Amalgamation	2 stamps	3
Austin [a]	do	Amalgamation, concentration.	5 stamps, 1 Johnson concentrator.	18

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
NEVADA COUNTY—con.				*Short tons.*
Zeibright	Nevada City	Amalgamation	1 Blake crusher, 10 stamps.	30
Consolidated St. Gothard.[a]	North Columbia.	Amalgamation, concentration.	1 crusher, 20 stamps, 4 Frue vanners, 4 Johnson concentrators.	80
Grizzly Ridge [a]	do	do	10 stamps, 4 Frue vanners.	40
Weeks Bros.[a]	Rough and Ready.	do	4 stamps, 1 Johnson concentrator.	8
Blue Rock [a]	Tyler	do	4 stamps, 1 Frue vanner	10
Ethel [a]	Washington	Amalgamation	10 stamps	40
Fairview [a]	do	Amalgamation, concentration.	1 crusher, 20 stamps, 4 Johnson concentrators.	80
Red Cross [a]	do	Amalgamation	Huntington mill	35
Daylight [a]	do	do	4 stamps (175 pounds)	1
Red Ledge [a]	do	do		2
Sycamore [a]	do	do	10 stamps	40
Washington [a]	do	do	20 stamps	80
Waldeck [a]	do	do	10 stamps (300 pounds)	5
ORANGE COUNTY.				
Santa Ana [a]	El Toro	Cyanidation	1 crusher, 10 stamps, 4 ore tanks, 4 agitation tanks.	50
PLACER COUNTY.				
Crandall [a]	Auburn	Amalgamation	5 stamps	20
Davenport [a]	East Auburn	Amalgamation, concentration.	5 stamps, 1 concentrator	15
Lyon	Auburn	do	1 Dodge crusher, 5 stamps, 1 Wilfley concentrator.	10
Lost Emigrant [a]	Donner	do	1 Blake crusher, 4 stamps, 2 Johnson concentrators.	12
Bonnie Bee [a]	Dutch Flat	do	1 Blake crusher, 5 stamps, 1 vanner.	24
Big Dipper [a]	Iowa Hill	Amalgamation	1 crusher, 10 stamps, (gravel mill).	50
Morning Star [a]	do	do	1 crusher, 10 stamps, (gravel mill).	50
Knaff	Newcastle	do	2 stamps	4
Hathaway [a]	do	Amalgamation, concentration.	20 stamps, 4 Johnson concentrators.	80
Big Bursar	do	do	1 Blake crusher, 10 stamps, 2 Johnson concentrators.	30
Three Stars [a]	Ophir	do	1 Gates crusher, 20 stamps, 4 Woodbury concentrators.	90
Dover [a]	Towle	do	10 stamps, 1 Woodbury concentrator.	35
Rawhide [a]	do	do	1 Blake crusher, 10 stamps, 2 Frue vanners.	35
Pioneer	do	Amalgamation, concentration, cyanidation.	1 Blake crusher, 20 stamps, 1 tube mill, 8 Frue vanners, ore tanks, 2 agitation tanks, 1 filter.	70
Black Canyon [a]	Westville	Amalgamation	1 crusher, 30 stamps	180
Pennsylvania	do	do	1 crusher, 30 stamps	100
Mars [a]	do	do	3 stamps	4
Canada Hill [a]	do	do	5 stamps	20
Prairie Flower [a]	do	do	5 stamps	15
PLUMAS COUNTY.				
Hoes [a]	Buck	Amalgamation, concentration.	1 Gates crusher, 5 stamps, 1 Union concentrator.	20
Homestake [a]	do	do	5 stamps, 1 Frue vanner	5
Little California [a]	do	Amalgamation	5 stamps	8
Needed Wealth	do	do	4 stamps	8

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
PLUMAS COUNTY—continued.				*Short tons.*
Peppins [a]	Buck	Amalgamation, concentration.	Huntington mill, 1 Frue vanner.	16
Crescent [a]	Crescent Mills	Amalgamation	8 stamps	12
Premium [a]	do	do	5 stamps	10
Oro Fino	Quincy	Amalgamation, concentration.	5 stamps, 2 Johnson concentrators.	20
Five Bears	Genesee	do	10 stamps, 2 Eccleston concentrators.	20
Gruss	do	do	1 Gates crusher, 15 stamps, 2 Gates tables.	90
Arcadia [a]	Greenville	Amalgamation	10 stamps	12
Altoona	do	Amalgamation, concentration.	1 Denver crusher, 1 Denver mill, 1 Card concentrator.	25
Droege	do	do	2 Blake crushers, 25 stamps, 5 Pinder concentrators.	80
New York	do	do	1 Blake crusher, 10 stamps, 1 Frue vanner.	15
McLellan [a]	Greenville	Amalgamation	2 stamps	5
Jamison	Johnsville	Amalgamation, concentration.	1 Gates crusher, 10 stamps, 4 Johnson concentrators.	70
Plumas Eureka	do	do	3 crushers, 40 stamps, 4 Wilfley concentrators.	120
Plumas Mohawk [a]	do	Amalgamation	2 crushers, 4 Huntington mills.	80
Plumas Bonanza [a]	Nelson Point	do	1 Blake crusher, 2 stamps.	8
Crown Point	Quincy	do	1 Blake crusher, 10 stamps.	20
White Oak [a]	do	do	5 stamps	15
White Lily	Seneca	do	1 Blake crusher, 10 stamps.	40
Bluff City	Spring Garden	do	10 stamps	25
Elizabeth [a]	Taylorsville	do	8 stamps	24
RIVERSIDE COUNTY.				
Lost Horse [a]	Banning	do	10 stamps	20
Desert Queen	do	Amalgamation, cyanidation.	8 stamps, 4 cyanide tanks.	10
Contact	do	Amalgamation	2 stamps	2
Hexahedron	Indio	do	1 Blake crusher, 5 stamps.	15
American Flag [a]	Paloverde	do	1 Blake crusher, 7 stamps.	20
Good Hope	Perris	do	1 Blake crusher, 20 stamps.	50
SAN BERNARDINO COUNTY.				
Orange Blossom [a]	Bagdad	Amalgamation, concentration.	1 crusher, 20 stamps, 6 Deister concentrators.	60
Paradise Mountain [a]	Barstow	Amalgamation	10 stamps	35
O. K.	Dale	Amalgamation, cyanidation.	1 Dodge crusher, 10 stamps, six 50-ton ore tanks, 2 agitation tanks, 6 percolation tanks.	40
Virginia Dale [a]	Dale	Amalgamation	Lane mill	25
White Star [a]	do	do	5 stamps	20
Jumbo [a]	Hart	do	10 stamps	25
Garvanza [a]	Leastalk	do	2 crushers, 20 stamps	100
Gold Bank [a]	Ibis	do	1 crusher, Huntington mill.	20
Gold Mountain [a]	Victorville	do	2 Gates crushers, 40 stamps.	120
Guarantee [a]	do	do	5 stamps	10
SAN DIEGO COUNTY.				
Nobles [a]	Descanso	Amalgamation	5 stamps	15
Cleveland Pacific [a]	Escondido	Amalgamation, concentration.	1 crusher, 5 stamps, 1 Standard concentrator.	16
Ready Relief [a]	Julian	Amalgamation	10 stamps	40

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
SAN DIEGO COUNTY—continued.				*Short tons.*
Julian Consolidated[a]	Julian	Amalgamation, concentration, cyanidation.	1 Blake crusher, 10 stamps, 2 concentrators, 5 ore tanks.	50
Owens[a]	do	Amalgamation, concentration.	1 crusher, 10 stamps, 2 Johnson concentrators.	30
Boulder Creek[a]	Lakeside	Amalgamation, cyanidation.	1 crusher, 1 Lane mill, 3 cyanide tanks.	20
SAN LUIS OBISPO COUNTY.				
La Cuesta[a]	San Luis Obispo	Amalgamation, concentration.	1 crusher, 10 stamps, 2 concentrators.	40
SHASTA COUNTY.				
Ruby Pearl[a]	Castella	Amalgamation	Bryan mill	5
American[a]	French Gulch	do	10 stamps	40
Brunswick	do	do	10 stamps	40
Connor	do	do	2 stamps	6
Gem[a]	do	do	2 stamps	6
Gladstone	do	Amalgamation, concentration.	2 Blake crushers, 30 stamps, 6 Frue vanners, 4 Johnson and 3 Wilfley concentrators.	100
Washington	do	do	5 stamps, 2 Johnson concentrators.	10
Milkmaid	do	Amalgamation, concentration, cyanidation.	10 stamps, 4 Johnson concentrators, 2 ore tanks, 2 percolation tanks.	30
Moonlight[a]	Ingot	Amalgamation	5 stamps	15
Clipper & Snyder[a]	Kimberley	Amalgamation, concentration.	1 crusher, 10 stamps, 2 Woodbury concentrators.	15
Uncle Sam	Kennett	do	10 stamps, 4 concentrators	40
Nellie	Keswick	do	1 Blake crusher, 15 stamps, 4 Johnson and 4 Wilfley concentrators.	50
Midas	Knob	do	2 Blake crushers, 20 stamps, 6 Frue vanners.	75
Victor[a]	do	do	3 Nissen stamps, 2 Johnson concentrators.	25
Mariana Marsicano[a]	Ono	Amalgamation, cyanidation.	1 crusher, 5 stamps, 3 ore tanks, 3 percolation tanks.	20
Old Spanish[a]	Redding	do	1 Blake crusher, 5 stamps, 2 Johnson concentrators.	15
Mount Shasta[a]	Shasta	Amalgamation, concentration.	1 Blake crusher, 6 stamps, 4 Woodbury concentrators.	12
Shasta Monarch	do	do	1 Hendy crusher, 5 stamps, 1 Woodbury concentrator.	12
SIERRA COUNTY.				
Little Bear Creek[a]	Alleghany	Amalgamation, concentration.	1 crusher, 2 stamps, 1 Frue vanner.	7
Plumbago	do	do	1 Hercules crusher, 1 Blake crusher, 20 stamps, 4 Johnson concentrators.	65
El Dorado[a]	do	do	10 stamps, 2 Johnson concentrators.	20
Independence	do	do	1 Blake crusher, 5 stamps, 1 Johnson concentrator.	15
Kenton	do	do	1 Blake crusher, 10 stamps, 4 Frue vanners.	35
Rainbow	do	do	10 stamps, 4 Frue vanners (burned and reconstructed).	30
Tightner	do	do	1 jaw crusher, 10 stamps, 2 Johnson tables.	30
Gold Canyon[a]	Moores Flat	do	1 crusher, 5 stamps, 2 Frue vanners.	20

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
SIERRA COUNTY—con.				*Short tons.*
Gray Eagle[a]	Downieville	Amalgamation	1 crusher, 10 stamps	30
Willoughby	Downesville	Amalgamation, concentration.	10 stamps, 2 Pinder concentrators.	30
Kate Hardy	Forest	do	3 stamps, 1 Deister table.	12
Four Hills	Johnsville	do	2 crushers, 20 stamps, 4 concentrators.	60
Alaska	Pike	do	40 stamps, 2 Wilfley, 2 Deister tables.	150
Butte Saddle	Sierra City	do	10 stamps, 1 Woodbury concentrator.	30
Cleveland	do	Amalgamation	1 crusher, 10 stamps	35
Hayes[a]	do	do	1 Blake crusher, 20 stamps.	80
Keystone	do	Amalgamation, cyanidation.	1 Blake crusher, 10 stamps, 6 cyanide tanks.	35
Primrose[a]	do	Amalgamation	2 crushers, 10 stamps	40
Sierra Buttes	do	Amalgamation, cyanidation.	1 Blake crusher, 40 stamps, 12 cyanide and percolation tanks.	60
Swastika[a]	do	Amalgamation	1 Huntington crusher, 10 stamps.	35
Sovereign[a]	do	Amalagmation, concentration.	1 crusher, 2 roller mills, cyanide plant (not completed 1912).	40
SISKIYOU COUNTY.				
Black Bear[a]	Black Bear	Amalgamation	16 stamps	32
Adeline Ricks	Callahan	Amalgamation, concentration.	10 stamps, 2 concentrators.	30
Eaton	do	Amalgamation	5 stamps	6
Trail Creek	do	do	1 Dodge crusher, 2 Huntington mills.	20
Advance[a]	Etna Mills	Amalgamation, concentration.	1 crusher, 5 stamps, 1 Wilfley concentrator.	15
Highland	do	Amalgamation	2 stamp Hendy mill	5
Keating	do	do	Hendy 2-stamp mill	12
Taylor Lake[a]	do	Amalgamation, concentration.	Sturdivant crusher, 10 stamps, 1 Frue vanner, 1 Johnson concentrator.	30
Denure & Burton	Fort Jones	Amalgamation, cyanidation.	2 stamps, 4 ore tanks, 4 agitation tanks.	10
Sheba	do	Amalgamation, concentration.	1 Union crusher, 10 stamps, 2 Frue vanners.	30
Gold Run	Gilta	do	10 stamps, 2 Johnson vanners.	30
Knownothing[a]	do	Amalgamation	8 stamps	12
Pilot Knob[a]	Gottville	do	5 stamps	10
Sun Down[a]	do	do	do	17
Morrison-Carlock[a]	Greenview	do	do	24
Fleetwood[a]	Hawkinsville	do	Tube mill	10
Livingston[a]	Hilt	do	2 stamps	8
Rose City[a]	do	Amalgamation, cyanidation.	10 stamps, 10 ore tanks, 2 percolation tanks.	25
Jillson	Henley	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 2 Jacobs vanners.	30
Indian Girl	Hornbrook	do	Graupner mill, 1 Johnson concentrator.	20
Ida May[a]	Rollin	Amalgamation	2 stamps	16
Brown Bear[a]	Sawyers Bar	Amalgamation, concentration.	1 crusher, 4 stamps, 1 Frue vanner.	9
Jumbo	do	Amalgamation	10 stamps	10
Columbia	Scott Bar	do	5 stamps	20
Lanky Bob[a]	Snowden	Amalgamation, concentration.	1 Dodge crusher, 2 stamps, 1 Frue vanner.	5
Dannenbrink[a]	do	Amalgamation	2 stamps	2
Dividend[a]	Yreka	do	5 stamps	20
Mono[a]	do	Amalgamation, concentration, cyanidation.	1 Blake crusher, 10 stamps, 1 Johnson and 1 standard vanner, 6 ore tanks, and percolation tanks.	30
Eliza[a]	do	Amalgamation, concentration.	10 stamps, 2 Pinder tables	25

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
TRINITY COUNTY.				*Short tons.*
Adams Exploration [a]	Carrville	Amalgamation	1 Dodge crusher, 1 Huntington mill.	12
Belli	do	do	5 stamps	20
Blue Jay	do	Amalgamation, concentration.	1 Blake crusher, 1 Graupner mill, 1 Norborn concentrator.	15
Coffee Creek [a]	do	Amalgamation	1 Rock breaker, 20 stamps	40
Headlight	do	Amalgamation, cyanidation.	2 crushers, 40 stamps, 3 Dorr classifiers, 5 leaching tanks, 10 slime tanks, 3 Pachuca agitators, 2 Oliver filters.	250
Brown Bear	Deadwood	Amalgamation, concentration.	10 stamps, 2 Wilfley tables.	24
Lappin [a]	do	Amalgamation	5 stamps	20
Goodyear, Richards	do	do	2 stamps, canvas plant	5
Globe Consolidated	do	Amalgamation, cyanidation.	1 crusher, 20 stamps, Door classifier, 3 Pachuca agitators, 2 Burt filters.	100
Ridgeway [a]	Denny	Amalgamation, concentration.	10 stamps, 1 concentrator.	15
Boomer	do	Amalgamation	1 crusher, 3 stamps, 1 Huntington mill.	12
Dorleska [a]	Dorleska	do	1 Gates crusher, 10 stamps	35
Hickory [a]	do	do	5 (250-pound) stamps	2
Yellow Rose [a]	do	do	1 Huntington mill	10
Bully Choop [a]	Douglas City	do	30 stamps	90
Salmon Summit [a]	Forks of Salmon	Amalgamation, concentration.	2 stamps, individual mortars, 1 Pinder concentrator.	10
Enterprise	Helena	do	1 crusher, 10 stamps, 1 Woodbury concentrator.	18
Grizzly [a]	do	Amalgamation	5 stamps	5
Venecia	Lewiston	Amalgamation, concentration.	1 Huntington mill, 2 Frue vanners.	10
Fairview	Minersville	Amalgamation	1 Hendy and 1 Blake crusher, 40 stamps.	130
Supplanter	Quimby	do	1 crusher, 3 stamps	7
Quimby	do	do	1 Blake crusher, 1 Huntington mill.	30
Trinity Bonanza [a]	Trinity Center	do	1 crusher, 20 stamps	80
TUOLUMNE COUNTY.				
Big Casino [a]	Big Oak Flat	Amalgamation, concentration.	2 Blake crushers, 20 stamps, 4 Frue vanners.	60
Longfellow [a]	do	do	25 stamps, 5 Frue vanners	70
Nonpareil	do	do	1 Blake crusher, 10 stamps, 2 hydraulic classifiers, 2 vanners, 1 Gates, and 2 standard concentrators.	40
Little Sisters	do	Amalgamation	1 crusher, 2 stamps	4
Tarantula [a]	Chinese camp	Amalgamation, concentration.	1 gyratory crusher, 20 stamps, 4 Cone classifiers, 4 Frue vanners, 4 Wilfley tables.	120
Dorsey	Columbia	Amalgamation	2 stamps	6
Contention [a]	do	Amalgamation, concentration.	1 crusher, 10 stamps, 2 Gates concentrators.	40
Ethel	do	do	1 crusher, Huntington mill, 2 Frue vanners.	12
Experimental	do	Amalgamation	1 crusher, 3 stamps	8
Experimental Gulch	do	Amalgamation, concentration.	1 crusher, 2 stamps, 1 Frue vanner.	4
U. S. Grant [a]	do	do	3 stamps, 2 concentrators	10
Riverside [a]	do	do	1 crusher, 10 stamps, 2 Jackson concentrators.	10
Old Tuolumne [a]	do	Amalgamation	1 crusher, 5 stamps	10
Morning Glory	Confidence	Amalgamation, concentration.	1 crusher, 2 stamps, 1 Frue vanner.	8
Duleek [a]	Groveland	do	1 crusher, 10 stamps, 2 vanners.	30
Del Monte [a]	do	do	3 stamps, 2 concentrators	3

[a] Idle in 1912.

Reduction mills in California in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
TUOLUMNE COUNTY—continued.				*Short tons.*
Imperial	Jacksonville	Amalgamation, concentration.	1 crusher, 10 stamps, 4 concentrators.	40
Clio [a]	do	do	1 crusher, 10 stamps, 4 Frue vanners.	40
Crystalline [a]	Jamestown	do	1 Blake crusher, 10 stamps, 4 Frue vanners.	40
Harvard	do	do	2 Blake crushers, 60 stamps, 6 Frue vanners, 18 Johnson concentrators.	350
Rawhide [a]	do	do	1 Blake crusher, 40 stamps, 8 Frue vanners (dismantled).	140
O'Donnell	do	do	5 stamps, 1 Frue vanner	20
Wickham [a]	do	do	5 stamps, 2 Frue vanners.	20
Dutch	Quartz	do	Blake crusher, 40 stamps, 10 Frue vanners and 10 Johnson vanners.	200
App	do	do	2 Blake crushers, 60 stamps, 24 Frue vanners.	300
Eagle Shawmut	Shawmut	Amalgamation, concentration, chlorination.	2 Gates crushers, 100 stamps, 40 Frue vanners, 1 Card and 1 Deister concentrator, 25 tons daily capacity chlorination works, 2 Edwards furnaces, tilting type, 1 Hall furnace.	500
Sugarman	Sonora	Amalgamation	1 Huntington mill	5
Black Oak [b]	Soulsbyville	Cyanidation	1 Blake crusher, 20 stamps, 1 tube mill, 2 Dorr thickeners, 3 Pachuca agitators, 1 Oliver filter. (Ore is treated by cyanide only.) [b]	85
Bagdad Chase [a]	do	Amalgamation, concentration.	1 crusher, 20 stamps, 4 vanners.	80
Jumper	Stent	Amalgamation	20 stamps	60
Mazeppa [a]	do	do	10 stamps	30
Santa Ysabel [a]	do	do	2 crushers, 40 stamps	120
Dreisam	Tuolumne City	do	1 Blake crusher, 6 stamps.	6
Hardtack [a]	do	Amalgamation, concentration.	2 stamps, 1 vanner	4
New Era [a]	do	do	10 stamps, 2 concentrators.	30
Rose Spring	do	Amalgamation	1 Blake crusher, 3 stamps.	12
Mohican [a]	do	do	5 stamps	18
Providence	do	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 2 Frue vanners.	40
Rising Sun [a]	do	do	3 stamps, 1 vanner	20
Starr King	do	Amalgamation	5 stamps	12
United Mines	do	do	20 stamps	80
Arbona [a]	do	Amalgamation, concentration.	1 crusher, 10 stamps, 4 Frue vanners.	30
Chileno	Tuttletown	do	3 stamps, 1 Union concentrator.	10
Cross	do	do	6 stamps, 1 Frue vanner	8
VENTURA COUNTY.				
Oro Fino [a]	Lebec	Amalgamation	1 Dodge crusher, 5 stamps	14
YUBA COUNTY.				
California Mother Lode. [a]	Dobbins	do	1 crusher, 10 stamps	25
Good Title	do	Amalgamation, cyanidation.	2 stamps, 1 cyanide tank.	2
Red Cross	do	do	1 crusher, 2 stamps, 6 cyanide and 6 percolation tanks, 4 agitation tanks.	6
Santa Rosa [a]	Rackerby	Amalgamation, concentration.	1 crusher, 5 stamps, 1 Frue vanner.	10

[a] Idle in 1912.
[b] Description of mill and process in Min. and Sci. Press, Nov. 30, 1912.

Summary of active reduction mills in California in 1912, by counties.

County.	Number of plants.	Crushers.	Number of stamps.	Roller mills.	Tube mills.	Concentrators.	Cyanide plants.	Capacity in 24 hours.
								Short tons.
Alpine	1	1	20			10		80
Amador	12	10	404			150		1,923
Butte	3	1	14	1				60
Calaveras	13	10	430			182	1	2,006
Eldorado	5	1	30			7		101
Fresno	1		1			1		10
Humboldt	1	2		2		1		50
Inyo	5	7	60	2		12		280
Kern	12	6	193	3		7	4	718
Los Angeles	2	2	13			1	1	42
Madera	2	1	5	2		2		60
Mariposa	13	9	187			27		642
Modoc	3		25				4	65
Mono	4	4	48		1	1	3	264
Nevada	20	24	409			106	5	1,355
Placer	5	4	67		1	11	1	214
Plumas	11	11	106	1		21		525
Riverside	4	2	32				1	77
San Bernardino	2	2	30			6	1	100
Shasta	9	6	107			38	1	363
Sierra	13	10	195			27	2	580
Siskiyou	11	3	56	3		9	1	213
Trinity	12	9	133	4		6	2	621
Tuolumne	23	18	389	3	1	126	1	1,900
Yuba	3	2	9			1	2	18
Total	190	145	2,963	21	3	752	30	12,267

Summary of idle reduction mills in California in 1912, by counties.

County.	Number of plants.	Crushers.	Number of stamps.	Roller mills.	Tube mills.	Concentrators.	Cyanide plants.	Capacity in 24 hours.
								Short tons.
Alpine	1	1	16			17		80
Amador	10	8	303			110		1,268
Butte	5	4	39	1		4		170
Calaveras	27	15	440			141		2,014
Eldorado	24	5	215	2		48		974
Fresno	4	1	8	2		1	2	59
Humboldt	2		4					14
Imperial	3	2	100	2	1	1	3	570
Inyo	10	5	54	1		2	2	231
Kern	20	13	172	3		20	9	636
Lassen	2		10	2				140
Los Angeles	1	1	3			1		18
Madera	8	3	41	3		12		227
Mariposa	14	5	138	2		8		433
Mono	5	1	57			8	1	158
Nevada	40	19	450	1		91	1	1,598
Orange	1	1	10				1	50
Placer	14	7	132			15		530
Plumas	12	4	55	5		3		215
Riverside	2	1	17					40
San Bernardino	9	6	110	2		6		415
San Diego	6	4	40	1		5	2	171
San Luis Obispo	1	1	10			2		40
Shasta	10	4	50	1		11	1	183
Sierra	9	8	72	3		6	1	287
Siskiyou	18	5	111		1	10	2	300
Trinity	11	4	107	2		2		319
Tuolumne	21	14	273			57		925
Ventura	1	1	5					14
Yuba	2	2	15			1		35
Total	293	145	3,057	33	2	582	25	12,114

PRODUCTION BY COUNTIES.[1]

AMADOR COUNTY.

Number of mines producing in Amador County, Cal., quantity of ore sold or treated in in 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	36	649,693	$2,420,161	21,420	10,000	$2,434,659
1906	26	579,599	2,260,376	21,760	8,648	2,276,624
1907	36	444,341	2,116,182	20,477	5,300	2,130,757
1908	34	422,155	1,876,174	24,980	55,788	1,896,777
1909	51	480,674	2,298,785	32,118	113,995	2,330,305
1910	50	577,934	2,646,246	36,883	151,480	2,685,401
1911	50	656,806	2,832,395	54,526	227,848	2,889,775
1912	44	737,148	2,796,194	52,093	175,542	2,857,195
Increase (+) or decrease (−) in 1912	−6	+80,342	−36,201	−2,433	−52,306	−32,580

In the production for 1911 both the quantity and the value of all metals for Amador County increased; in 1912 they decreased, with the exception of the item of tonnage, although the total decrease in value of output amounted to only $32,580. Notwithstanding this slight falling off, the county still continues to lead all other counties of the State in tonnage of ores treated—with 737,148 tons in 1912—exceeding the next county in order of rank in this respect, Calaveras, by 307,020 tons. Amador is now also the leading gold-producing county of the State, having displaced Yuba County, which held first rank in 1910 and 1911, thus making a quartz-mining county rank above any of the placer or dredge mining counties like Butte, Yuba, or Sacramento, two of which in turn displaced Nevada County some years since, as the greatest of the gold-producing counties of California. The quantity of gold produced in Amador in 1912 was 135,265.89 fine ounces. The value of the silver was $32,037, and of the copper $28,964.

There were 11 productive placer mines in the county in 1912, and 33 deep mines, 44 in all. The total output of ore in the county was 737,148 tons. There was an increase of output of 80,342 tons in 1912 as compared with 1911.

Of the total output, 877 tons of copper ore were shipped to smelters, and 673,498 tons, or 91.3 per cent of the total tonnage, was treated in the gold and silver mills. From this milling ore $1,734,737 in gold and 18,685 ounces of silver was saved as bullion, an average gold value of $2.57 per ton, and an average silver value of 0.018 cent per ton. The total gold and silver saved as bullion was valued at $1,746,228, an average value of $2.59 per ton. From this milling ore was obtained 13,985 tons of concentrates, which yielded $1,013,246 in gold, an average of $72.45 per ton, and 17,603 ounces of silver, an average of 77 cents per ton, a total average value of $73.22 per ton in gold and silver. The extraction of gold from bullion and concentrates was $2,747,983, an average of $4.08 per ton, and the

[1] For reference to United States Geological Survey publications on the mining districts of California, see Hill, J. M., The mining districts of the western United States: Bull. U. S. Geol. Survey No. 507, 1912.

recovery of silver was 36,288 ounces, an average value of 0.03 cents per ton. The value of the total yield of gold and silver from milling ore was therefore $2,770,300, an average value of $4.11 per ton. The yield of the placers in the county was 712.47 fine ounces of gold, valued at $14,728, and 145 ounces of silver, valued at $89. Of the placers 1 was a hydraulic mine, 6 were drift, and 4 were sluicing properties.

In 1912 the deep mines at Amador City produced 158,630 tons of ore (including 60,000 tons of tailings), which yielded $472,146 in gold and $3,743 in silver, a total value of $475,889. Of the deep-mine producers of this place the Bunker Hill Consolidated Mining Co. is the most important. At the Bunker Hill tailings plant the sand is separated from the slime and treated by leaching with sodium cyanide. The slimes are treated on automatic canvas plants, yielding a dirty concentrate which is treated by agitation and decantation. The Original Amador Mines has a productive property at Amador City. At the Keystone mine the main, or Patton shaft, has been sunk over 1,000 feet below the bottom of the old shaft, and the 2,600-foot station has been started. Crosscutting for east and west ore bodies is in progress. The 40-stamp mill of the South Spring Hill mine was burned in January, 1913. The Fremont Consolidated is the only producing property at Drytown. It has 2 incline shafts, 1,550 and 2,200 feet deep, respectively, and 200 feet of shaft sinking was done in 1912. The consolidation includes the Fremont, Gover, North Gover, and Loyal Lode claims. None of the mines at Defender made any production in 1912. At Ione, the Ione Coal and Iron Co. crushes and concentrates its gold-silver-copper ore and ships the concentrates to the smelter of the Mountain Copper Co. Some ore from the old dumps of the Newton copper mine was shipped by lessees.

At Jackson and Sutter Creek are the most important gold mines in the State in tonnage and yield. The mines at these places, lying all within a few miles radius, may be considered as in one district. In 1912 the group of deep mines at these places produced 499,407 tons of ore, yielding $2,072,774 in gold and $14,878 in silver, a total of $2,087,652. The Argonaut at Jackson has a shaft sunk on an incline of 60 degrees to 4,000 feet depth, and extensive development work was carried on in 1912, including connection by raises from the 1,460-foot level to the bottom of the neighboring Muldoon shaft, 1,000 feet deep. The Kennedy, one of the largest producers in the State, has the deepest vertical shaft in the State,—now 3,894 feet—and excellent ore continues to be mined. The mill of the Zeila mine was running most of the year, with from 10 to 25 stamps in use. At the Hardenburg, being reopened, there is a 1,000-foot vertical shaft, and a new 20-stamp mill is being built. The South Amador Co. has been prospecting the Queen mine under option to purchase. A new property at Jackson is the South Jackson, where 577 feet of vertical shaft sinking has been done and prospecting by crosscuts carried on. The Central Eureka, at Sutter Creek, has an incline shaft 2,875 feet deep and is among the large producers, and the East Eureka is also a productive mine. The South Eureka is one of the largest producers in the State and is developed by an incline shaft 2,930 feet deep. About 4,500 feet of development work was done in 1912. The Lincoln Consolidated Mining Co. owns

the old Wildman-Mahoney mines, which were being prospected up to December, 1912, when operations temporarily ceased on account of a flood of water from the old Wildman workings. The same company also opened the Amador Queen shaft in 1912 and did some prospecting on the 500 and 1,100 foot levels. At Pine Grove the Katz and Mountain Queen mines, and the Memphis and Rosenwald at Plymouth were worked in a small way. At the latter place the Plymouth Consolidated mines, which had been closed for 20 years, were equipped with a new surface plant by the California Exploration Co. (Ltd.), and unwatered by the end of September, 1912, after which some of the old workings were reopened and about 450 feet of drifts and raises were driven. The few productive placers in the county are at Oleta, Lancha Plana, Plymouth, and Volcano.

BUTTE COUNTY.

Number of mines producing in Butte County, Cal., quantity of ore sold or treated, 1905–1912, and total gold, silver, and lead produced.

Year.	Number of mines producing.	Quantity.	Gold.	Silver.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	82	1,058	$2,590,886	10,907	.....	$2,599,244
1906	63	682	3,016,747	16,199	.....	3,027,600
1907	72	.....	2,786,840	13,587	.....	2,795,807
1908	75	1,215	3,139,398	23,978	.....	3,152,106
1909	49	1,316	2,987,079	13,856	.....	2,994,284
1910	76	13,578	2,487,791	11,851	659	2,494,220
1911	82	2,575	2,323,396	9,627	.....	2,328,498
1912	77	3,326	2,346,229	9,053	.....	2,351,796
Increase (+) or decrease (−) in 1912	−5	+751	+22,833	−574	.....	+23,298

In 1912 Butte County produced an increase in gold and a slight increase in silver value, as compared with the year 1911. The productive mines of the county comprise 3 hydraulic, 28 dredge, 19 drift, 18 surface, and 9 deep mines—77 in all. The dredges produced $2,271,996 in gold in 1912 and $2,251,764 in 1911, a gain of $20,232. With 30 dredges operating in 1911 and 28 in 1912, it may be seen that the dredging industry is more than holding its own in the county, and that the predicted reduction in gold yield is not yet evident. The hydraulic mines of the county produced $1,947 less gold in 1912 than in 1911, the drift mines $8,608 more, and the sluicing mines $13,587 less. The total output of gold from placers of all kinds in 1912 was $2,324,928, as compared with $2,311,622 in 1911, a gain of $13,306. The deep mine gold output was $21,301 in 1912 and $11,774 in 1911, a gain of $9,527 in 1912. The total value of the silver output for 1911 was $5,102 and in 1912 it was $5,567, an increase of $465. Butte is now the second county in rank of annual gold yield from dredging operations, Yuba exceeding it in this respect. The following table shows the gold output from the Oroville field for several years past, with the annual decrease or increase.

Gold output of Oroville (Cal.) dredging district, 1903–1912, with increase (+) or decrease (−), by years.

1903	$1,329,998	
1904	1,632,507	+$302,509
1905	2,261,887	+ 629,380
1906	2,768,782	+ 506,895
1907	2,697,092	− 71,690
1908	3,043,151	+ 346,059
1909	2,743,232	− 299,919
1910	2,099,628	− 643,604
1911	1,987,294	− 112,334
1912	2,080,229	+ 92,935

This table applies to the dredges in the Oroville district or field only, there now being in Butte County 4 other dredges at work in "outside" districts. The combined output of these outside dredges in 1912 was $191,767, as compared with $264,470 in 1911 and $289,607 in 1910.

In 1912 the following dredging companies were operating in the Oroville field, each with 1 machine unless otherwise noted: Boston & California; Boston & Oroville; El Oro (2 dredges); Gold Run; Indiana; Natomas Consolidated of California (3 dredges); Ophir (2 dredges); Ora Vista; Oroville Gold Dredging (3 dredges); Oro Water, Light & Power (4 dredges); Pacific (3 dredges); Pennsylvania; and Viloro Syndicate. Of the 2 dredges of the Ophir, 1 was inoperative in 1912, although enumerated in the number of dredges in the field. The Oro Water, Light & Power Co. had 5 dredges working in 1911 and 4 in 1912; and the Pacific had 4 at work in 1911 and 3 in 1912. There were therefore actually at work in 1912 in the Oroville field 23 dredges and 4 in the outside districts of the county. The companies at Butte Creek and Honcut, outside the Oroville district, are the Butte Creek Consolidated, Drexler, Kentucky Ranch, and Honcut.

As to other placer operations in the county in 1912, there was some drift mining being done at Bangor and Berdan, and there were half a dozen small mines in operation at Brush Creek and Cherokee. Placer work in drifting and sluicing was being carried on in a small way at Coutolene, Enterprise, De Sabla, Inskip, Magalia, and Nimshew. The placers at Stirling City are all small sluicing operations.

The deep mines producing were the Crystal Peak, of Enterprise; the Carlisle, of Forbestown; and the Triumph, of Lumpkin—the latter the only important deep mine. The Bumble Bee and Wyandotte were small producers.

The P. B. Steifer drift mine at Magalia was pumped out and the electric power increased, with 3 new electric pumps added. There is as yet no output. At the Forbestown Consolidated Gold Mines operations were started in 1912 with repairing the shaft to a depth of 1,600 feet along the Gold Bank and Golden Queen claims. A new 20-stamp mill and cyanide plant were installed.

CALAVERAS COUNTY.

Number of mines producing in Calaveras County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	56	547,972	$1,780,485	105,693	3,666,810	$2,416,345
1906	48	583,207	1,644,234	110,597	5,082,320	2,699,221
1907	77	295,441	1,097,974	82,454	4,386,243	2,029,643
1908	59	481,669	1,378,511	118,353	4,473,030	2,031,678
1909	94	566,665	1,440,511	137,342	5,416,315	2,216,050
1910	71	436,263	1,147,705	155,248	7,302,331	2,158,935
1911	78	482,983	1,112,315	126,476	5,681,200	1,889,497
1912	70	430,128	962,145	115,037	6,089,819	2,037,713
Increase (+) or decrease (−) in 1912	−8	−52,855	−150,170	−11,439	+408,619	+148,216

In view of the decrease in output of ore in 1912, as compared with 1911 as shown in this table, the falling off in gold product in Calaveras County is not surprising. The value of the copper output of the county in 1912, however, was $1,004,820, as compared with $710,150 in 1911, an increase of $294,670. The silver value also increased $3,716. The increased copper and silver values, therefore, overcome the decrease in gold, leaving a total net increase of $148,216 for all metals. In 1912 productive mines to the number of 70 reported, 37 deep gold mines, 2 copper mines, 3 hydraulic, 3 dredge, 11 drift, and 14 surface mines. The average value of the 371,568 tons of milling ore treated in gold and silver mills in 1912 was only $1.88 per ton in gold and silver, compared with $1.91 per ton from 417,905 tons in 1911. This is much the lowest average value per ton in gold and silver of any of the mother lode counties, and, indeed, is the lowest in the State. In the carrying on of development much "waste" must have been milled. For example, a certain mine recovered an average of only $1.50 per ton; another $2 per ton; and still another $1.43 per ton.

The output of ore sold or treated in Calaveras County in 1912 was 430,128 tons, yielding 36,209.22 fine ounces of gold, valued at $748,511; 114,047 ounces of silver, valued at $70,139; and 6,089,819 pounds of copper, valued at $1,004,820. The output of placer gold was 10,334.54 fine ounces, valued at $213,634, and 990 ounces of silver, valued at $609. The output of the county in 1912 in gold, silver, and copper was valued at $2,037,713.

There were 371,568 tons of ore treated at gold and silver mills, from which was obtained $350,675 in gold by amalgamation, or 94 cents per ton, and 4,597 ounces of silver, valued at $2,827, or 1 cent per ton. The total saving in bullion was valued at $353,502, or 95 cents per ton. From this 371,568 tons of ore were obtained 8,649 tons of concentrates, yielding $339,376 in gold and 11,564 ounces of silver, valued at $7,112, an average of $39.23 per ton in gold and 82 cents in silver, or a total average value of $40.05 per ton. The milling ore yielded $690,051 in gold, the average recovery in gold per ton being $1.85; in silver the average recovery was 3 cents per ton; the total gold and silver recovery was therefore valued at $1.88 per ton. There were 55,357 tons of

smelting ore sold or treated, yielding $55,174 in gold, valued at $0.99 per ton, and 97,836 ounces of silver, valued at $60,169, or $1.08 per ton, and 6,089,819 pounds of copper, valued at $1,004,820. The total value of this smelting ore was $1,120,163, or $20.23 per ton.

There were also 3,203 tons of old tailings treated, yielding in gold $3,286, and in silver 50 ounces, valued at $31. The average recoverable value per ton of the tailings in gold and silver was $1.04.

At Angels, the leading quartz camp of the county, the combined mine yield in 1912 was $405,803 gold and $5,684 in silver, which is much less than in 1911. Some former large producers have been doing much development work, and litigation has prevented operations on others. The Angels is one of the oldest mines at this place. At the Dolling the mill was operated four months in 1912, but prospecting and developing was continued during the year. At the Lightner, changes in ownership and company troubles have retarded operations. The Utica and Gold Cliff are under one management. The Utica has two vertical shafts, one 1,000 and the other 1,400 feet deep, and two winzes, one 375 and the other 550 feet, with thousands of feet of drifts and crosscuts. The Gold Cliff has a shaft of 800 feet deep and a winze 900 feet, with thousands of feet of development work. These two mines and others at Angels were closed for lack of water power for three months of the year.

The Penn Mining Co. of Campo Seco has an 800-ton blast furnace and a 120-ton reverberatory furnace, the matte and cement copper being shipped to the American Metal Co., New York. Considerable gold and silver is obtained with the copper. The Finnigan Mining Co. was a small producer at Carson Hill, as was the Blue Bird at Camanche. The Calaveras Copper Mining Co., at Copperopolis, owns the old Union, Keystone, and Empire mines, and has been shipping its ores to the Mammoth Copper Co. of Maine, at Kennett, Cal., for reduction. A 400-ton concentrator and a 150-ton smelter were in course of construction during the year. The Klondike is a small producer at Glencoe. The Melones Mining Co., at Melones, has one of the extensive properties of the county, which is opened by an adit 5,000 feet long on the 1,100-foot level, and a winze from there 500 feet. The winze has been sunk and development work started on the 1,350-foot and the 1,600-foot levels. In addition to the milling plant described in the list of reduction mills in this section, a cyanide plant for the treatment of concentrates will be operated during 1913. An electric hoist has been installed for operating the mine below the adit, or 1,100-foot level. This has a capacity of hoisting 15,000 pounds at 1,000 feet per minute. The quartz mines at Mokelumne Hill were all small producers, as are those at Mountain Ranch and Murphy. Several mines with small production were in operation at Railroad Flat, Valley Springs, and West Point. The productive placers in the county are near Angels, Douglas Flat, Jenny Lind, Murphy, Mokelumne Hill, North Branch, San Andreas, and Wallace. There were 3 dredges in operation near Jenny Lind—the Butte, the Calaveras, and the Isabel. Their combined gold output in 1912 was $175,636. The hydraulic mines of the county yielded $7,081; the drift mines, $21,134; and the surface placers, $9,783. The Channel Mining Co., at San Andreas, after making quite a large output from its drift mines in 1912, ceased operating early in 1913, as the gravel was not rich enough to pay a profit.

Among the nonproducers of Calaveras County the Ingomar Consolidated Co., at Campo Seco, has changed to oil as fuel, put in a new compressor, and continued development from April to end of year. At Camanche the Oro Water, Light & Power Co., put in a gold dredge, but did not commence operating until February, 1913. The Stockton Ridge Consolidated Co., at Mokelumne Hill, in 1912 ran 550 feet of a 2,400-foot tunnel, and put in a new rotary mill. At the Petticoat mine, Railroad Flat, the shaft was unwatered and repaired, and a new head-frame was built.

ELDORADO COUNTY.

Number of mines producing in Eldorado County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1905	58	36,708	$385,596	3,253	160,000	$412,521
1906	61	31,818	431,746	4,015	.....	434,436
1907	61	33,781	319,177	3,486	.....	321,478
1908	64	10,521	342,033	10,385	.....	347,537
1909	48	27,431	238,284	2,498	.....	239,583
1910	64	17,383	171,304	1,791	.....	172,271
1911	56	11,444	133,967	1,905	.....	134,977
1912	51	8,871	105,565	1,371	.....	106,408
Decrease (—) in 1912	— 5	— 2,573	— 28,402	— 534	.....	— 28,569

Eldorado, which is one of the five Mother Lode counties in California, in 1912 produced 5,106.71 fine ounces of gold, valued at $105,565, and 1,371 ounces of silver, valued at $843, a total value of $106,408, or $28,569 less than in 1911. The ore mined, amounting to 8,871 tons, was all treated at gold and silver mills. The gold saved on the plates was $38,939, or an average of $4.39 per ton, and 909 ounces of silver, valued at $559, was recovered, the total recovery from the plates being valued at $39,498, an average value of $4.45 per ton. There were 102 tons of concentrates derived from the milling ore, which yielded $3,961 in gold and 106 ounces of silver, a total value of $4,026 in gold and silver, or $38.83 per ton in gold and $0.63 in silver per ton, an average value of $39.46 in both gold and silver. The milling ore yielded, therefore, on the plates and from the concentrates, a total of $42,900 in gold, or an average per ton of $4.83, and silver valued at $624, or $0.07 per ton, or a total value of gold and silver of $43,524, or $4.90 per ton.

The placer mines of the county yielded 3,031.42 fine ounces of gold, valued at $62,665, and 356 ounces of silver, valued at $219. Of the gold $1,100 came from 1 hydraulic mine, $54,759 from 21 drift mines, and $6,806 from 11 sluicing or surface mines. There were 51 producing mines in the county in 1912, of which 33 were placers and 18 were deep mines.

The Barnes Eureka, Lookout, and South End, at Eldorado, were small producers, as also the Combine, Barklage, and Homestead, at Georgetown; the Sunrise, at Grizzly Flat; and the Richmond, at Omo Ranch. The Guilford Mines Co., Placerville, extended the tunnels 840 feet and made raises amounting to 313 feet during the year.

The mine was closed for several months in 1912, resuming operations in December. The Placerville Gold Mining Co., at Placerville (Pacific mine) with a shaft 1,200 feet deep, did 1,210 feet of drifting and 151 feet of sinking during the year. The productive placers are the Encinal and Livingston, at Fairplay; the Georgetown drift, Blue Rock, Gold Bug, Gold Channel, Parsons, and Delwich, at Georgetown; the Bordt, at Greenwood; the Thanksgiving, at Omo Ranch; the Chili Ravine, Klondike, Ideal, and Live Oak, at Placerville; the Dividend, at Shingle; and the Kumfa-Carpender, at Smith Flat. The Mount Gregory drift mine at Virner is the most productive in the county. Development work was carried on upon a few of the unproductive mines in 1912, but for the most part they were entirely idle.

DEL NORTE AND HUMBOLDT COUNTIES.

The only productive mines in Del Norte County were placers, of which 3 hydraulic mines yielded $1,313 gold in 1912, and 5 surface placers yielded $2,627, a total of $3,940. The placer silver yield amounted to 16 ounces only. The mines are all near Crescent City and at one of them the black sands of the ocean beach are being mined. A plant has been provided for working the property more extensively.

Humboldt County has only 1 deep mine, and 14 placers, 12 of which are worked by the hydraulic system. These are mainly at Orleans, although there are a few at China Flat, Orick, and Weitchpec. The hydraulic mines of the county yielded a total of $30,680 gold, and the placers $291. The silver yield was 243 ounces, and the total gold and silver output was valued at $31,421. All the mines of the county were small producers, the water being in scant supply during 1912.

FRESNO COUNTY.

The production of Fresno County in 1912 was $6,117 in value of gold and silver, all from deep mines, which is a decrease of $11,405 from the total of 1911. There were 603 tons of ore treated in the county, yielding 294.80 fine ounces of gold, valued at $6,094, and 37 ounces of silver, valued at $23. The producing mines reported were the Graveyard, at Pine Ridge; the Sunnyside group, at Sanger; and the Eliza Jane, at Trimmer. The ore of the Sunnyside is treated in an arrastre. The property of the Fresno Copper Co., at Clovis, continued inoperative, and the Hart copper mine, at the same place, was also idle. The M. & M. Mining Co. (White Cross), at Dunlop, continued development operations during the entire year, and the plant has been moved to the new tunnel on the 450-foot level, but there was no output.

INYO COUNTY.

Number of mines producing in Inyo County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	24	8,907	$91,501	84,622	151,606	447,723	.....	$187,307
1906	16	3,401	19,449	19,937	4,145	208,018	.....	45,464
1907	17	17,684	57,241	67,333	15,587	2,596,399	233,550	256,186
1908	25	39,440	308,873	58,302	3,690	1,110,952	.....	386,920
1909	34	79,625	457,846	90,609	31,722	1,490,649	.....	573,185
1910	33	52,963	408,509	239,982	58,047	2,866,894	.....	671,614
1911	50	101,662	574,945	86,185	29,504	1,329,756	2,624,719	833,759
1912	51	70,615	369,758	73,685	45,033	997,999	4,345,591	767,261
Increase (+) or decrease (−) in 1912	+1	−31,047	−205,187	−12,500	+15,529	−331,757	+1,720,872	−66,498

There were 51 productive deep mines in Inyo County in 1912, but no placers. Of the deep mines 30 were gold, 2 copper, 4 silver, 14 silver-lead-zinc, and 1 zinc. The total value of the output was $767,261, which is $66,498 less than in 1911. The value of gold output was $369,758. The value of the silver was $45,316; of the copper, $7,431; of the lead, $44,910; and of zinc, $299,846. The greatest decrease for 1912 was in the gold output, this amounting to $205,187; the value of the silver decreased only $362; the copper increased $3,743; the lead decreased $14,929; and the zinc increased $150,237. Three mines in this county produced zinc in 1912.

There were treated in 1912 in Inyo County 70,615 short tons of ore, of which 63,184 tons were siliceous ore, 55 tons were copper ores, 904 tons were lead ores, and 6,472 were zinc ores. The deep mines in 1912 yielded 17,887.04 fine ounces of gold, valued at $369,758. The silver yield was 73,685 ounces, valued at $45,316. Of gold, 17,795.22 fine ounces, valued at $367,860, were obtained from siliceous ore; from copper ores were obtained 16.50 fine ounces, valued at $341; the lead ores yielded 56.31 fine ounces, valued at $1,164; and the zinc ores 19.01 fine ounces, valued at $393, were obtained. The silver production from the siliceous ore was 22,598 fine ounces, valued at $13,898; from the copper ores, 3,124 ounces, valued at $1,921; from the lead ores, 21,289 ounces, valued at $13,093; and from the zinc ores, 26,674 ounces, valued at $16,404. The siliceous ore yielded, therefore, $381,758 in gold and silver; the copper ores, $2,262; the lead ores, $14,257; and the zinc ores, $16,797, a total of $415,074 in gold and silver for the county.

The Gem, Cashier, Golden Rod, Mountain Girl, and Lucky Strike mines at Ballarat were all small producers. The Arondo gold mines (Searles, Kern County) made a considerable output in 1912, but the property has since been abandoned, and is now (1913) closed down. The Bruckerman and Fish Springs Hill mines at Big Pine made only nominal outputs. The Golden Siren, Gray Metal, and Silver Bow mines at Bishop were small producers. At Darwin the producers are the Golden Argus, Christmas Gift, Yucca, Hughes, Lucky Jim, and Silverite mines. Neither the Tubb, at Death Valley, nor the

Black Eagle or Birthday, at Independence, made large outputs. The Independent Mining & Leasing Co., at Keeler, shipped some copper ore. Little was done on the Reward & Brown Monster mine. "Chloriders" worked the Virginia group at Independence. The Ella, Shady, and Perseverance mines, at Keeler, produced ore carrying lead, copper, and zinc. The zinc ore shipped to Springfield, Ill.; Argentine, Kans.; Collinsville, Okla.; and Neodesha, Kans., from the old Cerro Gordo [1] mine at Keeler carried, in addition to zinc, gold, silver, copper, and lead. This is the largest producer in the county. Other producers of shipping ore at Keeler were P. Gelrig, Spear Bros., Swansea-Chief mine, Ventura group, and H. S. Schaffer. The X-Ray and Golden Marriage of Laws produced small shipments of smelting ore. The Skidoo Mines Co., at Skidoo, is one of the large producers of the county. The Utah is another producer at that place. The mines making outputs at Tecopa are the Blue Dick, Arcturas (Ibex), and Paloma. The Keane Wonder, at Keane Wonder, was not continuously operated during the year, but nevertheless made a considerable output. At a number of mines in this county development or assessment work only was reported.

KERN COUNTY.

Number of mines producing in Kern County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	46	252,776	$1,121,370	170,469	.....	.....	$1,224,333
1906	36	146,076	806,117	193,288	.....	.....	935,620
1907	40	236,853	878,798	130,353	.....	.....	964,831
1908	44	259,968	827,087	182,170	144	.....	923,656
1909	53	242,104	654,799	195,488	.....	.....	756,432
1910	51	197,550	619,974	64,891	.....	569	655,040
1911	53	180,687	557,471	11,005	33,224	600	567,484
1912	44	168,226	830,420	18,667	1,064	20,011	842,976
Increase (+) or decrease (−) in 1912	−9	−12,461	+272,949	+7,662	−32,160	+19,411	+275,492

With a smaller tonnage of ore than in 1911, and 41 deep mines active out of the 44 producers in the county, Kern increased its gold yield in 1912 by $272,949, and shows a total increase in value of output of all metals of $275,492 for the year. The total silver value was $11,480, as compared with $5,833 in 1911—an increase of $5,647; a decrease in value of copper output of $3,977 is shown; the lead value increased $873. There were 41 deep mines and 3 placers producing. The placers are the Keyesville, at Isabella; the Placer Gold Co., at Randsburg; and the Bonanza and Deep Diggings, at Ricardo. The gold from the last named is obtained by "dry washing," and it is one of the few mines of the State reported productive by that system.

There were treated 168,197 tons of siliceous ore in 1912, of which 164 tons were crude ore sent to the smelter and 3,421 tons were

[1] Knopf, Adolph, Mineral resources of the Inyo and White mountains, California: Bull. U. S. Geol. Survey No. 540–B, 1913, pp. 20–43.

tailings. There were also 6 tons of copper ores and 23 tons of lead ores sent to the smelters, making a total output of 168,226 short tons of ore. The yield in bullion from the 164,612 tons of ore treated at gold and silver mills was $807,896 in gold, an average of $4.91 per ton, and 11,928 ounces of silver, making a total bullion value of $815,232 in gold and silver, with an average value per ton of $4.96. From this ore were derived 10 tons of concentrates yielding $62 in gold and 7 fine ounces silver, making a total value of $66, with an average of $6.60 in gold and silver per ton. The 193 tons shipped to the smelter yielded $2,122 in gold and 6,717 ounces of silver, a total of $6,253, with an average of $32.40 in gold and silver. From the 3,421 tons of old tailings treated was produced $17,670 in gold, an average of $5.19 per ton. The total yield of the county in gold and silver from deep mines was $839,221, an average of $4.98 per ton of ore treated.

The Randsburg[1] district is the most productive in the county, and the mines there in 1912 produced 164,227 tons of ore, yielding $741,360 in gold and $5,787 in silver, as well as 20,011 pounds of lead, valued at $900, and 1,064 pounds of copper, valued at $176, a total value of $748,223, as compared with a total of $509,696 in 1911. The Randsburg district is therefore responsible for a very large proportion of the total increase in value of the county yield for 1912, the increase for the district alone having been $238,527. The Butte Lode, at Randsburg, has been worked by lessees of late. The new 5-stamp mill of the Good Hope was not quite completed at the end of 1912. A small production obtained during development work came from the G. B. At the Josephine about 200 feet of shaft and drift work was done during the year. The Magganetta was among the smaller producers in the camp, and larger ones were the Gold Dollar (Orphan Girl), Phoenix, and Merced. The Sunshine made a small output, and considerable gold and silver came from the King Solomon, Consolidated, Windy, Santa Ana, Ajax, and Pinmore mines. The Yellow Aster Mining Co. has by far the most important producing property at Randsburg, and indeed the most important in southern California. The group consists of 44 claims (717 acres). The main mine is developed by a shaft 700 feet in depth, by more than 10,000 feet of drifts, and by about 2 miles of adits. The mine was worked by the "glory hole" or quarry system entirely during 1912. A compressed air-pump was added at the Mountain wells water plant, and others are to be put in at other mills. Electricity is to be used as motive power. The ore at this mine is entirely "free milling" and the gold is saved by plain amalgamation on plates only.

At Amalie are the Golden group, Gold Peak, Amalie, and Sand Creek Canyon mines; contiguous to Bakersfield, the Harris Bros. and Hockmeir; and at Bodfish, the Glen Olive, all small producers. The King Solomon is quite an important producer at Haight Canyon, east of Havilah. The Lone Star, of Havilah, made a small output. The producers at Isabella were the Early Sunrise, Old Keyes, and Mammoth Mountain. At the last the mill is being rebuilt. The Ajax

[1] Hess, F. L., Gold mining in the Randsburg quadrangle, California: Bull. U. S. Geol. Survey No. 430, 1910, pp. 23–47.

is near Johannesburg; and at Loraine are the Alexander and the Jeanette. The producers at Piute are the Bryan Chief, Gold State, and Rex mines; the Antelope Valley is at Rosamond; and the Grizzly at White River.

As to nonproducers in Kern County, the Mohave Consolidated Gold Mines have bought the Exposed Treasure, Desert Queen, and Yellow Rover groups at Mohave, made additions to the plant, and started operations on these old properties in May, 1913. The Baltic, at Randsburg, started its mill in 1913, changing to electric power furnished by the new power line running through Randsburg. The Tropico Co., at Rosamond, idle since 1910, started up early in 1913. The mill and cyanide plant were put in operation.

MADERA COUNTY.

The 6 deep mines of Madera County (there are no productive placers) made a production of 1,580 tons of ore in 1912, yielding 443.21 fine ounces of gold, valued at $9,162; 1,890 fine ounces of silver, valued at $1,162; and 232,347 pounds of copper, valued at $38,337, a total valuation of $48,661, which is an increase of $43,565 over that of 1911. This showing is almost entirely due to the results of copper mining in the county. The increase of copper output in 1912 was 207,859 pounds in quantity and $35,276 in value. The producing gold mines are the Krohn, at Coarse Gold; Madera Consolidated (Gambetta), at Grub Gulch; and the Quartz Mountain, at O'Neals. The copper mines were the Buchanan and the Probasco, in the vicinity of Raymond. Among the nonproducers the Texas Flat mine, at Coarse Gold, was unwatered in 1912 and the caved portions of the shaft and of various levels were reclaimed, after the mine had been idle three years. The 20-stamp mill was again started in April, 1913. The Rex, at Grub Gulch, was being reopened and retimbered. Operators of the Mud Springs mine, at O'Neals, were retimbering and sinking the shaft and erecting a modern mill. A cyanide plant for treating 5,000 tons of tailings on hand was being installed.

MARIPOSA COUNTY.

Number of mines producing in Mariposa County, Cal., quantity of ore treated or sold in 1905–1912, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity of ore.	Gold (value).	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	27	88,316	$433,370	6,763	12,541	$439,411
1906	25	64,511	366,394	5,040	.....	369,771
1907	24	51,139	405,498	6,288	7,984	411,245
1908	27	53,972	439,862	8,928	36,757	449,446
1909	34	52,103	396,465	5,247	.....	399,194
1910	38	42,703	317,580	4,377	.....	319,941
1911	32	18,196	172,532	2,623	13,528	175,613
1912	38	21,094	160,541	11,051	300,062	216,847
Increase (+) or decrease (−) in 1912	+6	+2,898	−11,991	+8,428	+286,534	+41,234

Mariposa, one of the Mother Lode counties of California, produced more ore in 1912 than in 1911, but $11,991 less gold was recovered. The silver value, however, was $6,796 in 1912, as compared with $1,390 in 1911, an increase of $5,406; and the copper value in 1912 was $49,510 as compared with $1,691 in 1911, an increase of $47,819. The deficit in gold yield, therefore, is more than offset by increased values in silver and copper production, so that the total increase in values of the metals in 1912 is $41,234. The deep mines produced 21,094 tons of ore, 2,351 tons of which went to the smelter. The 18,743 tons of ore which went to the gold and silver mills yielded $140,885 in gold as bullion, averaging $7.51 per ton, and 6,202 ounces of silver, valued at $3,814, the total gold and silver value of the mill bullion being $144,699, or an average of $7.72 per ton. From this tonnage were also derived 586 tons of concentrates which yielded $14,223 in gold and 1,016 ounces of silver, a total value of $14,848. The concentrates therefore yielded $24.27 per ton in gold and $1.07 per ton in silver, an average yield of $25.34 per ton in both gold and silver. The 2,351 tons sent to the smelter yielded $2,267 in gold, 3,800 ounces of silver, and 300,062 pounds of copper, an average value per ton for gold, silver, and copper of $23.02. The siliceous ore yielded on the plates and from the concentrates a total value of $159,547 in gold and silver, an average total value of ore treated of $8.51 per ton.

Thirty-eight mines were productive in the county in 1912, of which 28 were deep gold mines, 4 were copper, and 6 were placers, all but one of which, a drift mine, were sluicing mines. These were at Bagby, Jerseydale, Kingsley, and Mariposa, and their total output was only $3,166 gold and 33 ounces of silver, valued at $20.

At Bagby the producers were the Crown Lead, Kockel, and W. Taft, and at Ben Hur the Ben Hur, Green Mountain, and Copper Queen. Some small pocket mining was done in the Bear Valley section. The Champney pocket mine at Coulterville was profitably worked. Other mines at the latter place are the Mountain View, Oro Rica, Scanlon, and Reich. The Original Mining Co. is operating at El Portal, and a small production was made from the old Hite mine at the same place by the Woodside Mining Co. Among the most productive mines in the county are those of the Mariposa Commercial & Mining Co., which has a 5-stamp mill (River mill) at Bagby, a 10-stamp mill (Princeton) at Mount Bullion and a 5-stamp mill at Mariposa. The mines are all on the Mariposa grant and are operated entirely by lessees on a percentage basis, mostly by drifts, shafts, raises, etc., of a temporary nature. At Hornitos the Ruth Pierce and Treasure mines operated in a small way, as also the Revel and Midway mines at Jerseydale. The Carrie Todd and Trujillo at Kingsley, the Klondike at Lewis, and the Golden Gate at Mariposa were all small producers. The Pocahontas (copper) mine at Lewis, opened by a 300-foot incline shaft, was the most productive property in the county in 1912. The Mountain King Mining & Milling Co. at Mountain King made a considerable output with its 34-stamp mill (4 Nissen and 6 batteries of 5 stamps). The Spread Eagle was the only producer at Whitlock. Among the nonproducing mines, the Cavin at Ben Hur is being opened by tunnels. At the Bondurant, at Coulterville, the mill and equipment will be remodeled to use electric power. The plant is to be

enlarged. The Melvina mine of the Merced Co., at Coulterville, is now under option and the 1,000-foot shaft has been unwatered. At the Virginia mine (Coulterville) an electric power line for further operations is being built.

MERCED, SHASTA, SISKIYOU, AND STANISLAUS COUNTIES.

In Merced and Stanislaus counties there were only two producers, both dredges. In Shasta and Siskiyou counties are numerous productive mines, both deep and placers, but in each of these counties there is only one productive dredge reported. Therefore to avoid disclosure of confidential data, the four dredges of these four counties have been combined as to their output of gold and silver. The arrangement works an injustice to Shasta County, inasmuch as the gold product of its single dredge is not included in its total output in the State tabular statement, but is credited to the four combined counties named above. The same may be said of Siskiyou to a smaller degree. The combined output from gold-dredging operations in Merced, Shasta, Siskiyou, and Stanislaus counties was $326,419 in gold and 1,619 ounces of silver, valued at $995, a total of $327,414.

MODOC COUNTY.

Modoc County produced in 1912 from 2,171 tons of ore $27,893 in gold and 803 fine ounces of silver, valued at $494, a total of $28,387, as compared with $20,238 in 1911, an increase for 1912 of $8,149. The few productive mines are the Dixie Queen, Hess, Big Four, Fort Bidwell Consolidated, Modoc, and Sunshine High Grade, all deep gold mines at Adin, Fort Bidwell, and High Grade. The most important of these mines is the Hess at Adin, to which the mill has been moved from Pit River. The Big Four at Fort Bidwell has a small mill. With the exception of the Hess none of these mines produced as much as $5,000.

MONO COUNTY.

Number of mines producing in Mono County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	13	23,444	$311,958	15,876	.....	.....	$321,547
1906	7	28,599	338,698	19,628	.....	.....	351,849
1907	8	32,363	383,971	45,147	.....	.....	413,768
1908	11	39,190	413,946	49,310	.....	2,429	440,182
1909	13	48,536	354,909	72,677	3,454	582	393,175
1910	12	24,913	435,724	17,391	.....	.....	445,115
1911	13	33,469	261,232	66,996	.....	44,289	298,733
1912	15	32,399	377,518	114,800	7,866	24,445	450,518
Increase (+) or decrease (−) in 1912	−2	−1,070	+116,286	+47,804	+7,866	−19,844	+151,785

Although the output of ore for 1912 in Mono County showed a decrease, yet the gold output increased over that of 1911 by $116,286, the silver value by $35,094, and the copper value by $1,298. The

lead value decreased by $893. The total increase in metallic output for the year is therefore valued at $151,785. All the mines are deep ones; there being no placers. There were 15 productive mines in 1912.

There were 15,400 tons of crude ore treated at the gold and silver mills, yielding $359,736 in gold and 100,291 ounces of silver, a total of $421,415 in gold and silver, and an average of $27.36 per ton in gold and silver. The total value of the gold and silver produced from all ores in the county was $448,120, an average of $13.83 per ton. The average value per ton in gold of the tailings treated was $1. The 75 tons of smelting ore treated produced $858 in gold, 14,509 ounces of silver, 7,866 pounds of copper, and 24,445 pounds of lead, valued in all at $12,179.

The producing mines at Benton are the Blind Spring Hill, the Marietta and Laurie (silver), and the Salton Hill. The most important camp in the county is Bodie, where the Mono, the New Bodie, and the Standard Consolidated produced 27,861 tons of ore, yielding $349,877 in gold and $61,457 in silver. The most productive mine in the county—the Standard Consolidated—is at this place. At this mine the crude ore is passed from the stamps to the tube mill, and thence to the cyanide plant, and the tailings are run through the tube mill to the cyanide plant. This is one of the two or three gold-mining companies in California which publishes an annual report through which details of costs may be learned. A total of 8,150.38 tons were mined, and the total cost was $10.718 per ton. In detailing these costs under development is noted: Labor, $3.70; lumber, $0.323; explosives, $0.284; candles, $0.055; other supplies, $0.030; stable, $0.161; yard, $0.033; power plant, $0.067; assay office, $0.098; blacksmith shop, $0.102; and machine shop, $0.003—a total development cost of $4.857.

Stoping cost is divided into labor, $4.335; lumber, $0.429; explosives, $0.388; candles, $0.075; supplies, $0.033; and ore purchased, $0.057; stable, $0.188; yard, $0.039; power plant, $0.078; assay office, $0.113; blacksmith shop, $0.122; machine shop, $0.004—an entire cost for stoping of $5.861 per ton, and a combined cost of all mining items of $10.718 per ton. In addition to ore from the mine the cyanide plant treated 16,596 tons of tailings from old slime ponds; the total realization from the 24,719 tons treated was $188,902. The tailing re-treated had an average value of $5.63 per ton. The cost of mining has been decreased from $12.67 in 1911 to $10.72 in 1912.

At the Golden Gate mine of the Hall Mining Co. (Colville), the property was only operated the last four months of the year, and the 10-stamp mill was constructed during the summer. The Don Alvarado at Lundy, the Jansen at Mono Lake, the Pittsburg Liberty at Masonic, and the Livingston at Topaz were all small producers. Of the unproductive mines the St. Ives has been sold to the Lone Star Mining Co., which has repaired the shaft and erected buildings and a new headframe. Development operations began in October, and the shaft was cleaned out.

NEVADA COUNTY.

Number of mines producing in Nevada County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1905	65	325,266	$3,076,997	41,129	.....	$3,101,839
1906	56	276,602	2,658,420	36,147	.....	2,682,639
1907	52	227,288	2,162,083	25,522	22,111	2,184,010
1908	48	220,067	2,297,963	41,347	.....	2,319,877
1909	56	232,034	2,660,235	47,935	.....	2,685,161
1910	49	250,358	2,533,483	30,566	.....	2,549,989
1911	44	263,062	2,199,147	29,606	.....	2,214,838
1912	44	270,148	2,081,958	37,122	.....	2,104,788
Increase (+) or decrease (—) in 1912	.....	+7,086	—117,189	+7,516	.....	—110,050

Notwithstanding the increase in tonnage of ore treated in Nevada County in 1912, there was a decrease of $117,189 in gold output. The increase of $7,139 in silver value, however, reduced the total decrease of output of the year to $110,050. This was due almost entirely to the falling off in deep-mine gold, which amounted to $116,845, while the placer gold only decreased by $344. The tonnage treated in 1912 in the county was 270,148. There were 44 productive mines in the county in 1912, of which 31 were deep gold mines and 13 were placers. The 7 drift mines yielded $14,154 in gold; the 2 hydraulic mines, $18,767; and the 4 surface placers, $12,195, a total from placers of $45,116 in gold. The deep mines produced 98,532.23 fine ounces of gold, valued at $2,036,842, and 36,738 fine ounces of silver, valued at $22,594, a total value of $2,059,436.

Nevada and Amador are the only counties in the State which, in 1912, produced over $2,000,000 in gold from deep mines, but Amador in this respect has exceeded Nevada County by $744,624 for the year—a most notable and remarkable fact.

There were 270,134 tons of siliceous ore treated at the gold and silver mills, which produced 4,073 tons of concentrates. There were also 14 tons of siliceous ore sent to the smelter in 1912. The value of the gold in the mill bullion was $1,927,294, or $7.13 per ton, and the silver output from the same source was 25,880 ounces, valued at $15,916, or $0.06 per ton. The total value of the gold and silver recovered in the mill bullion was $1,943,210, an average of $7.19 per ton. From the mill ore there was obtained 4,073 tons of concentrates, which carried $108,949 in gold, or an average of $26.75 per ton, and 10,829 ounces of silver, valued at $6,660, or an average of $1.63 per ton. The total value of the concentrates was $115,609 in gold and silver, or an average value of $28.38 per ton. From the total tonnage there was recovered $2,036,243 in gold, or an average value of $7.54 per ton, and 36,709 ounces of silver, valued at $22,576, or an average value of $0.08 per ton. The value of the total gold and silver obtained as bullion and concentrates was $2,058,819, the average being $7.62 per ton in gold and silver. There were no old tailings treated in 1912.

The principal quartz mining district of Nevada County is that of Grass Valley, which includes the mines in both Grass Valley and Nevada City.

The following table shows the production of Grass Valley district, 1904–1912:

Value of production of Grass Valley and Nevada City quartz mines, Nevada County, Cal., 1904–1912.

Year.	Grass Valley mines.			Nevada City mines.			Total.
	Gold.	Silver.	Total.	Gold.	Silver.	Total.	
1904	$1,738,979	$6,317	$1,745,296	$683,552	$3,400	$686,952	$2,433,248
1905	2,041,447	10,843	2,052,290	440,236	12,531	452,767	2,505,057
1906	2,196,990	16,516	2,213,506	133,031	5,755	138,786	2,352,292
1907	1,744,752	11,200	1,755,952	219,514	5,379	224,893	1,980,845
1908	1,869,176	11,953	1,881,129	192,037	8,552	200,589	2,081,718
1909	2,005,574	16,540	2,022,114	171,604	1,971	173,575	2,195,689
1910	2,113,499	13,101	2,126,600	118,688	1,731	120,419	2,247,019
1911	1,817,091	11,795	1,828,886	174,749	2,329	177,078	2,005,964
1912	1,779,401	18,168	1,797,569	75,890	2,169	78,059	1,875,628
Increase (+) or decrease (—) in 1912	—37,690	+6,373	—31,317	—98,859	—160	—99,019	—130,336

Both Grass Valley and Nevada City decreased in the value of their output for 1912—Grass Valley by $31,317 and Nevada City by $99,019. The decrease in yield of the entire district amounted to $130,336. The total ore treated in the district was 218,850 tons, of which 199,261 tons came from Grass Valley mines and 19,589 from those of Nevada City. The Grass Valley quartz mines produced 73.7 per cent of the tonnage of the whole county and the mines at Nevada City 7.2 per cent, the district of Grass Valley having therefore produced 80.9 per cent of all ores milled in Nevada County in 1912. The Grass Valley deep mines produced $1,779,401, or 87.4 per cent of the quartz gold obtained in Nevada County in 1912, and 80.4 per cent quartz silver, or 87.6 per cent of the total value derived from quartz ores. Nevada City deep mines produced $75,890, or 3.7 per cent of quartz gold obtained in Nevada County, and 9.5 per cent of quartz silver, or 3.8 per cent of the total value derived from quartz ores of the county.

Grass Valley district (including Grass Valley and Nevada City mines) produced 90.9 per cent of the quartz gold and 90 per cent of the quartz silver, and 91.1 per cent of the total value derived from quartz mining operations in Nevada County in 1912. The producing mines at Grass Valley in 1912 were the Ben Franklin, Brunswick Consolidated, Central Consolidated, Empire and Pennsylvania, Golden Gate, Idaho-Maryland, North Star, Prudential, Rough and Ready, and Sultana. At the Brunswick Consolidated a new vertical shaft has been sunk, the mine above the 1,250-foot level has been opened, and electric machinery has been installed. The Central Consolidated has 2 incline shafts and a 1,973-foot adit, with some 1,648 feet of drifts and raises. The Empire mines, among the most productive mines of the State, have an incline shaft of 4,600 feet, and over 6,000 feet of drifts and crosscuts were run during 1912. The "Pennsylvania shaft" has been acquired by this company. The Golden Gate was operated for only 2 months during 1912. The Idaho-Maryland has an incline shaft and winzes 2,187 feet deep and about 15,000 feet

of drifts. It is only open at present to the 1,000-foot level. The North Star, the most productive gold mine in the State, is opened by both inclined and vertical shafts. Mining operations were being continued at a depth of 5,300 feet on the incline. The past year's tonnage of ore was derived from stopes above the 3,000, 3,400, 3,700, and 4,000-foot levels, and development covered the 4,600-foot, the 5,000-foot, and the 5,300-foot levels, opening a considerable body of fair-grade ore. Prospecting work covered 2,088 feet in the Cincinnati property, but with little encouragement, so work was stopped in August, the mine only yielding ore valued at $3,653. The Champion mines at Nevada City have been purchased, and during 1912 development covered 8,500 feet. The Ural and the Merrifield veins were opened on the 1,000, 2,400, and 1,600 foot levels, respectively. In 1911 and 1912 a total of $369,334 was spent on the Champion in development and on account of purchase. The 20-stamp mill was repaired and ran on a test of ore from the 1,800 and 1,600 foot levels, the average value being $8.80 per ton, and a cyanide plant was erected at the mill. The ore production from the North Star properties since 1884 has been 1,035,194 tons, of a total value of $14,045,092, and the dividends paid up to end of 1912 have been $3,786,989. In 1912 the North Star mines consumed 24 flasks of quicksilver at its mills, 51,600 pounds of potassium cyanide, and 10,000 pounds of sodium cyanide.

Only a small output was made by the Prudential, and this from the work of lessees. The yield of the Rough and Ready was nominal. The Sultana is opened by an incline shaft 1,600 feet deep, and by 1,000 feet of drifts. The deep-mine producers at Nevada City, aside from the Champion, owned by the North Star Mines Co., at Grass Valley, are the California-Montana, Mountaineer, and Pittsburg-Gold Flat. At the California-Montana in 1912 electric power was installed for the entire plant, the operators having been unable to secure water for more than six months of the year. The Mountaineer was worked by tributers only. The Pittsburg-Gold Flat has been developing, but not milling steadily. At Gaston but little was done on the Erie Consolidated, which was worked under lease. The Gaston, at the same place, is opened by two crosscut tunnels, one 2,500 feet long, and the other 4,400 feet. At Graniteville the deep mines operated were the Ancho and the Republic. The Zeibright, near Emigrant Gap, is being worked through a 1,200-foot tunnel. At Washington the mines are small producers.

The productive placer mines of Nevada County are fewer than formerly, and their entire output in 1912 was $45,116 in gold and $236 in silver. The producers were the Liberty Hill, near Dutch Flat (Placer County); Fischer, at French Corral; Alta California and Posey drift, at Grass Valley; Stockdale, at Rough and Ready; Birdseye Creek, at You Bet (Nevada near Dutch Flat); and Omega (Suey Chong), at Washington.

PLACER COUNTY.

In 1912 Placer County produced gold and silver valued at $372,174, against $253,883 in 1911. The total gold yield in 1912 was 17,772.15 fine ounces, valued at $367,383, and the silver was 7,790 ounces,

valued at $4,791. The increase in gold output for 1912 over 1911 was $116,085. The deep mines produced from 27,729 tons of ore 5,938.66 fine ounces of gold, valued at $122,763; 6,320 fine ounces of silver, valued at $3,887; and 75,000 pounds of copper, valued at $12,375. The placer mine yield was 11,833.49 fine ounces of gold, valued at $244,620, and 1,470 ounces of silver, valued at $904. Of the placer gold, $36,291 came from 6 hydraulic mines, $92,378 from 3 dredges, $102,895 from 33 drift mines, and $13,056 from 12 sluicing mines. The placer gold yield of the county in 1911 was $213,040, or $31,580 less than in 1912. The deep mines increased their gold output by $84,505 more than in 1911. There were 54 producing placers in the county in 1912, and 11 deep mines, a total of 65. Placer County leads all others in the production of gold from drift mining, but that industry appears to be decadent, this county alone yielding from this source $43,880 less gold in 1912 than in 1911. In the entire State the drift mines yielded $387,992 in 1912, as compared with $479,900 in 1911, a decrease of $91,908. The most productive deep mine in the county is that of the Pennsylvania Gold Mining Co., at Westville (formerly the Herman), which is opened by an adit of 2,000 feet, a 300-foot shaft, and 2,000 feet of drifts. Some 700 feet of drifts and raises were cut in 1912. The property is equipped with a 30-stamp mill. The Consolidated Pioneer, at Towle, comes next in rank among deep-mine producers of note, followed by the Big Bursar Mining Co., at Newcastle, a new company which purchased the properties of the Orpheum Mining Co., owning the St. Lawrence claim. Among other producing deep mines of the county are the Valley View, Stella, Dewey, Eureka, and Quinn.

Of the placers, the Whiskey Bar mine, owned by the Gaylord Mining Co., is on bars in American River, where a dredge is being used. At Blue Canyon, the Haub and the Lost Camp gravel mines were worked profitably. Little is being done at Butcher Ranch, Colfax, or Dutch Flat. The drift mines and dredge at Forest Hill made a combined gold yield of $27,883 in 1912. These were the Big Bend, Carothers, Cache Rock, Paragon, and Red Point mines. At Gold Run the Canyon Creek, Gold Nugget, United Water & Power Co., and Indian Hill Canyon made a combined gold output of $16,435. The Iowa Hill drift mines were the Penn Valley, Pine Avenue, and San Francisco. The producing drift mines at Last Chance were the Red Star, Olympic, Lincoln Consolidated, Frankmont, Placer, and Pacific Slab Consolidated. Their combined yield was $27,503, the most productive mine being the Pacific Slab Consolidated. Gold to the amount of $88,694 came from the following mines near Loomis, all drift mines, except one dredge: King Placer, Beaver (dredging), F. & F., Coburn, Montezuma River, Barton, and Pendleton. The mines at Michigan Bluff, which produced altogether $22,034 in gold, were the Bigelow, German Consolidated, Imperial, and California-Hawaiian. At Towle, the Sunset drift mine was productive, and at Westville the American Hill and George Fulton.

At Butcher Ranch, the Pacific Gold Dredging Co. has purchased several hundred acres of gravel land on American River, and in 1913 installed a bucket dredge with a capacity of 7 cubic feet.

PLUMAS COUNTY.

Number of mines producing in Plumas County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	
1905	88	31,455	$269,992	1,847	1,066	.....	$271,274
1906	78	21,040	229,350	1,575	.....	.....	230,405
1907	80	23,907	219,355	1,436	.....	.....	220,303
1908	51	29,537	254,737	6,717	.....	.....	258,297
1909	54	27,795	157,491	1,130	.....	.....	158,078
1910	46	41,681	187,207	1,923	.....	1,114	188,294
1911	53	47,470	228,785	2,123	1,328	.....	230,076
1912	67	27,398	193,237	1,556	16,381	5,837	197,160
Increase (+) or decrease (−) in 1912	+14	−20,072	−35,548	−567	+15,053	+5,837	−32,916

The total yield from the mines of Plumas County in 1912 was $32,916 less than in 1911. The decrease of gold was $35,548, caused by the large falling off in tonnage, but increased values in copper and lead reduced the total shrinkage in value of output for the year. The gold production was 9,347.84 fine ounces of gold, valued at $193,237; the silver value was $957, the copper value $2,703, and the lead value $263. There were 27,368 tons of siliceous ore treated at the mills, which yielded $100,805 in gold and 628 ounces of silver, valued at $386. The crude ore sent to the mill yielded 435 tons of concentrates, which produced $8,477 in gold and 499 ounces of silver, valued at $307. The placer mines yielded 4,061.32 fine ounces of gold, valued at $83,955, and 397 ounces of silver, valued at $244. There were 45 producing placers and 22 producing deep mines. Of the former 8 were hydraulic mines, yielding $16,963 in gold; 14 were drift mines, yielding $56,931 in gold, and 23 were sluicing mines, yielding $10,061 in gold. There was an increase of 3 hydraulic mines and 6 drift mines in 1912 over 1911, and a decrease of 2 sluicing mines. Both hydraulic and drift mines increased their gold yield, and the surface mines decreased.

The most productive of the deep mines of Plumas County are at Johnsville. The Jamison Mining Co. at this place is the largest deep-mine producer of the county. All portions of the plant of this mine are run by water power, and it was only operated for 197 days during 1912, owing to shortage of water for power. The Plumas Eureka of the same place comes next in rank of output to the Jamison. The Hank Leiddy, near Brush Creek, the Caldwell group and the Needed Wealth, at Buck, and the Oro Fino, at Eclipse, were all small producers, as were the Five Bears and the Gruss, at Genesee. At the Altoona mine, at Greenville, the mill was only operated for 50 days. The Droege and New York were small producers at this place. At Quincy are the Aurora, Bushman, Crescent Hills, Crown Point, Gold Leaf Consolidated, Hungarian Hill, and Old Harry. The White Lily, at Seneca, was also a producer, but is in litigation over an apex suit.

Of the placer mines of the county, the Consolidated Placer and the Indian Hill are at Belden; the New York and Old Rutherford, at

Buck; the Brown Bear and Haskell Peak, at Clio; the Great Divide, at Crescent Mills; the Eichler, at Cromberg, and the Pactolian-Keystone, at Eclipse. At Johnsville are the Aboytis, Colombo, Gallagher, Hamilton, General Harrison, and West Elizabeth. At La Porte the Bellevue is an extensive drift mine. At Quincy are the Gold Mountain, Bessie, Hungarian Hill, Oversight, Plumas National, Schley, and Santa Cruz mines. The producing placer mines at Seneca are the Cameron, Independent, North End, and Yankee Bar. There are a few small placers at Spanish Ranch. At Taylorsville, where there are a number of copper properties, no output of gold, silver, or copper was made in 1912. The Engels Copper Mining Co. erected a 100-ton smelter in 1911, but it has never been blown in, and the ores mined are still on the dumps. The smelter can not be blown in until the fumes can be cleaned of sulphur. The company is investigating proper concentrating machinery and is contemplating its installation.

RIVERSIDE AND LOS ANGELES COUNTIES.

In Riverside County there were 7 producing deep mines and in Los Angeles County 3, there being no placers in either. In Riverside County there were only 1,645 tons of ore treated, yielding 977.27 fine ounces of gold, valued at $20,202, and 413 ounces of silver, a total value of $20,456. The Desert Queen and the Andecandia are small producers near Banning. The New El Dorado, at Indio, was only operated a few months, owing to shortage of water supply. At the Priest Ranger, at Blythe, a mill was in prospect to work the low-grade ores. At the Senate group (Palo Verde, or Carnation), a new gallows frame and hoist were put in and the shaft was fitted with rails for a skipway. At the Good Hope & Perris, at Perris, the mill was run a short time, and the Justice, at the same place, was a small producer. Los Angeles County, from 457 tons of ore, made a yield of 156.54 fine ounces of gold, valued at $3,226, and 64 ounces of silver, a total of $3,275. This was derived from the Topeka and Red Rover mines at Acton, and the Collins, at Neenach.

SACRAMENTO COUNTY.

Number of mines producing in Sacramento County, Cal., quantity of ore sold or treated, 1905–1912, total gold and silver.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Total value.
		Short tons.		*Fine ounces.*	
1905	8	.....	$650,624	2,745	$652,282
1906	8	.....	986,624	5,433	990,264
1907	12	.....	790,973	3,082	793,007
1908	20	.....	1,166,055	3,058	1,167,676
1909	12	.....	1,669,814	5,492	1,672,670
1910	17	150	1,396,874	8,530	1,401,480
1911	11	.....	1,812,826	5,749	1,815,873
1912	15	.....	1,712,587	5,762	1,716,131
Increase (+) or decrease (—) in 1912	+4	.....	—100,239	+13	—99,742

Sacramento County made in 1912 quite a material decrease in gold output, amounting to $100,239, owing to lessened output of dredging operations. There were 11 productive dredges working in 1912, as compared with 10 in 1911. The dredges in the county in 1912 produced $1,672,797 in gold, as compared with $1,805,071 in 1911, which shows a decrease of gold from this source in this field for 1912 of $132,274. There was only 1 drift mine producing in the county in 1911, with an output of $7,755, but in 1912 there were 4, with a combined yield of $39,790 in gold. The producing drift mines of the county were the Cohen, the Embach, and the Wright & Donelly; and the dredge operators were the Natomas Consolidated of California, with 9 dredges operating, the Union Dredge Co., with 1 dredge, and the Ashburton Mining Co., with 1 dredge. Of the Natomas Consolidated, dredge No. 7 went out of commission in May, 1912; No. 8 was destroyed by fire in October, 1911, and was being rebuilt in 1912; and No. 10, which was not finished until October, was worked only three months during 1912. The No. 7 is being reconstructed with a modern steel hull. The company dredged 22,155,162 cubic yards in 1912, the yield from the gold dredges being $2,020,635. The "cobbles" separated from the gravel in dredging are crushed into macadam by the extensive rock-crushing plants which have been installed. In November, 1912, a contract was closed with the State Highway Commission to supply 500,000 tons of rock, and the profit from this may be credited to "by-products" of dredging operations. This company is also engaged in extensive reclamation and irrigation enterprises on its property. Levees have been constructed, land cleared, pumping plants put in, and a water-distributing system constructed which consists of 21 miles of concrete-lined ditch, steel flume, siphons, main canal, and main and secondary laterals. A town (Citrus) has been laid out and lands subdivided. The land department (formed February, 1912) cleared 3,600 acres and prepared 6,300 acres for grain and alfalfa farming. The company produces table and wine grapes, olives, and oranges. The whole of the company's agricultural property has been put on a producing basis. From the rock-crushing plant, orchards, etc., a revenue in 1912 of $323,406 was derived. The original piece of land purchased by this company for dredging purposes was the old Natoma vineyard, in full bearing, where the main dredging operations still continue, but other adjacent lands were later purchased. As fast as the dredges finish with the land on this tract the cobble piles are crushed for road-building purposes and removed, the land is leveled and is then replanted at once. The operations of this company are such as to overcome the prejudices against gold dredging, which it was supposed laid all the tracts waste and destroyed them; but after the gold under the surface is removed by the dredges the new surface land is at once put into condition for use for agricultural and horticultural purposes.

SAN BERNARDINO COUNTY.

Number of mines producing in San Bernardino County, Cal., quantity of ore sold or treated 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	15	34,039	$434,461	66,969	52,603	.....	.....	$483,116
1906	15	37,271	354,830	50,396	514,031	30,700	.....	489,552
1907	27	26,158	158,676	123,241	590,649	9,020	.....	358,623
1908	49	25,182	180,511	67,366	201,993	117,024	.....	247,793
1909	35	4,449	40,071	24,173	148,312	11,366	.....	72,410
1910	25	7,102	55,093	18,822	5,992	1,545	.....	66,086
1911	55	18,190	127,367	67,061	679,984	23,466	182,316	259,355
1912	29	44,722	293,900	81,238	1,890,008	96,439	.....	660,053
Increase (+) or decrease (−) in 1912.	−26	+26,532	+166,533	+14,177	+1,210,024	+72,973	−182,316	+400,698

Notwithstanding the falling off of 26 in number of producing mines in San Bernardino County in 1912, as compared with 1911, the tonnage of ore treated increased by 26,532 tons, and the gold yield by $166,533. There was an increase also in output of silver, of copper, and of lead, but a decrease in the production of zinc. The total yield of the county considerably more than doubled in 1912, as compared with 1911—$141,343 more than double. This is a record no other county of the State made for 1912, and is almost entirely due to the operations of the Pacific Mines Corporation at Ludlow. The silver value of the county output in 1912 was $49,962, the copper value $311,852, and the lead value $4,339. For 1912 over 1911 the gold increase was $166,533, the silver value increase $14,420, the copper value increase $226,853, and the lead value increase $3,283. There was no zinc produced in 1912, but in 1911 there was an output of 182,316 pounds, valued at $10,392. There were 29 mines in San Bernardino County reported productive in 1912, all but 1 "dry-washing" placer being deep mines. Of these deep mines 16 were gold mines, 3 copper, 4 silver, and 5 silver-lead mines. There were 44,663 tons of siliceous ore sold or treated in the county in 1912, and 59 tons of copper ore, out of a total of 44,722 tons altogether. As to gold and silver yield, 3,899 tons of ore were treated at gold and silver mills, yielding $15,394 in gold and 1,670 ounces of silver. The 270 tons of concentrates produced yielded $91 in gold and 6,146 ounces of silver. The 39,823 tons of ore shipped to the smelter yielded $274,645 in gold and 73,371 ounces of silver; and 1,000 tons of old tailings were treated, yielding $3,010 in gold and 48 ounces of silver. The copper ores of the county yielded 33.62 fine ounces of gold and 213 ounces of silver. Ores of the silver and silver-lead mines are included in the siliceous ore milled or smelted.

By far the most important productive property in the county and the only one of note was that of the Pacific Mines Corporation at Ludlow (Stagg post office), which is opened by vertical and incline shafts, and on which 2,573 feet of drifts, upraises, and winzes were cut in 1912. The company has no reduction works, but ships its ore

to the United Verde Co. at Jerome, Ariz., for treatment. It is a large producer of gold, silver, and copper.

The Southwestern Lead Co., of Bagdad, has been using jigs for concentrating, but has put in a 100-ton mill with Stebbins concentrator. The Camp Rochester, Copper Butte, Seymour, and Harmon mines at Barstow are all small producers, as are the John Z. Barnet and Live Oak at Barnwell. The Calzona Mines Co., Calzona, shipped its ore to the Humboldt smelter, Arizona. The Alta Crown at Leastalk made a small shipment only to Salt Lake. Some silver ore was taken out of the Waterloo Mining Co.'s property at Daggett by lessees. The United Greenwater Copper Mining & Smelting Co. at Dale (Supply and O. K. mines) after the end of the year installed a dry-crushing and direct-cyaniding plant on the Supply property. The Fairbanks at Leastalk supplied ore to Midvale, Utah, for treatment. The American Eagle at Needles, Lawrence at Nipton, and Alta and Hysters at Silver Lake were small producers. At Victorville are the Dickerson, Gillian, Staples, and Yankee Girl mines. The Gibson and the Steece copper mines at Vidal and the Fine Gold Mining Co. at Yerma are small producers.

SHASTA COUNTY.

Number of mines producing in Shasta County, Cal., quantity of ore sold or treated, 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	38	214,036	$706,738	270,530	10,830,865	.....	$2,559,753
1906	30	327,482	819,144	648,482	22,477,304	.....	5,591,748
1907	35	342,856	791,997	560,926	25,457,417	.....	5,853,691
1908	39	556,922	1,131,832	976,596	33,852,842	.....	6,118,003
1909	34	854,256	1,600,489	1,414,346	50,013,511	.....	8,837,706
1910	46	696,333	1,533,728	1,201,676	40,397,284	196	7,313,097
1911	63	520,795	1,133,476	730,171	29,618,032	.....	5,222,988
1912	39	415,116	928,243	691,257	24,618,550	.....	5,415,426
Increase (+) or decrease (−) in 1912	−24	−105,679	−205,233	−38,914	−4,999,482	.....	+192,438

Shasta County is the most productive in metallic output in the State, its yield for the year 1912 being valued at $5,415,426, or $2,558,231 more than the next county in rank of total production, Amador. Although there was a marked decrease in the number of mines producing in 1912 as compared with 1911 in the yield of gold, in the fine ounces of silver, and in the quantity of copper, yet the final figures of total value show an increase of $192,438. This is owing to the fact that the silver value in 1911 was $387,258 and that it was $425,123 in 1912, an increase of $37,365 for 1912, and that, further, the value of the copper produced in 1911 was $3,702,254, whereas in 1912 it was $4,062,060, an increase of $359,806. The marked gradual decrease in quantity of copper produced in the county is owing to the closing down of several smelters and the restricted operations of others because of the smelter-fume litigation and the resultant injunctions. The greatest decrease in values is in the gold, for the reason that a number of gold mines formerly supplying ores to the smelters have been closed down,

having no reduction works of their own and comparatively a limited market for their ore.

The total number of deep mines from which production was reported was 30, as against 53 in 1911. Of these 25 were gold mines, 3 copper, and 2 silver. The output of 415,116 tons was made up of 66,829 tons of siliceous ore and 348,287 tons of copper ores.

From the placer mines of the county, exclusive of 1 dredge, was obtained approximately $5,201 in gold. The placer mines of the county include 1 dredge, 2 drift mines, and 6 surface mines.

The gold obtained from the deep mines was 44,652.16 fine ounces, valued at $923,042. There were 691,210 ounces of silver produced, valued at $425,094. The gold obtained from the siliceous ore amounted to 33,972.16 fine ounces, valued at $702,267, and that derived from copper ores was 10,680 fine ounces, valued at $220,775. The silver production from siliceous ore was 6,829 fine ounces, valued at $4,200, and that from copper ores was 684,381 ounces, valued at $420,894. The siliceous ore, therefore, yielded $706,467 in gold and silver, and the copper ores yielded $641,669 in gold and silver, a total of $1,348,136 in gold and silver from the deep mines. The gold and silver mills in Shasta County in 1912 treated 66,470 tons of ore, which yielded in gold bullion $664,526, an average of $10 per ton, and 5,876 ounces of silver, valued at $3,614, an average of $0.05 per ton. The total recovery of mill bullion was valued at $668,140, or an average value in gold and silver of $10.05 per ton. This ore produced 372 tons of concentrates, with a gold value of $37,024, and 852 ounces of silver, valued at $524, a total value in concentrates of $37,548. The average value per ton of the concentrates was $99.52 in gold and $1.40 in silver, a total average value of $100.92 per ton.

The gold value of the ore treated at the gold and silver mills was $701,550, an average of $10.55 per ton, the silver value was $4,138, or $0.06 per ton, and the total gold and silver value from mill bullion and from concentrates was $705,688, or an average recovery of $10.61 per ton.

The crude ore sent to the smelters, amounting to 348,319 tons, produced (in addition to the copper) $221,050 in gold, an average of $0.63 per ton, and 684,382 ounces of silver, valued at $420,905, or $1.20 per ton. The total value of gold and silver recovered from ore sent to the smelters was $641,955, or an average value of $1.83.

There were treated in the county 327 tons of old tailings in 1912, which yielded $442 in gold and 100 ounces of silver, valued at $61, or a total value of $503.

Of the 4 large copper-smelting plants which have been for some years in operation in Shasta County, the only one continuing work during 1912 was that of the Mammoth Copper Co. of Maine, at Kennett, and even its operations were somewhat curtailed owing to smelter-fume trouble. This has affected not only the output of copper, but that of gold and silver also, since numerous gold and silver mines heretofore active, as stated, have ceased operations for lack of market for their ores. The Mammoth, the largest producer in the State, had three furnaces in continuous operation in 1912, their approximate capacity being 275 tons each per day. The process is straight pyritic smelting, with converting plant, and the blister copper

produced is shipped to the U. S. Metals Refining Co., at Chrome, N. J. The same company worked the Original Quartz Hill mine for one month in 1912, the ore being shipped to the company smelter for reduction. The mine is near Kennett. At Buckeye the Potosi was a small producer. The deep gold mines at French Gulch are the most important in the county, and their combined output for 1912 was 38,525 tons of ore, yielding in gold $380,305 and $2,017 in silver. The larger proportion of this was derived from the Gladstone mine, which has a 3,000-foot tunnel and a shaft 1,100 feet deep. The next largest producer in the French Gulch district is the Western Exploitation Co., operating the Milkmaid and the Franklin mines. Other producing deep mines at French Gulch are the Brunswick, El Dorado & Eureka, Halcyon, Summit, and Washington. The Atlantic, Blue Bell, and Hammon are small producers at Igo. At Kennett, in addition to the Mammoth, are the Monarch, Uncle Sam, and Wildcat, all small producers. The Mountain Copper Co. and the Pittsburg & Mount Shasta were the only producers at Keswick. Here are the extensive Iron Mountain, No. 8, and Hornet mines of the Mountain Copper Co. The former reduction plant at the mine was closed down some years ago by litigation connected with smelter-fume damage and a new smelting plant was erected near Martinez, on the shores of San Francisco Bay, to which the ore is shipped by rail from the mine, a distance of 250 miles. The sulphide ore is roasted to manufacture sulphuric acid, and the calcines, with suitable mixture of other ores, are smelted in reverberatories. The copper matte carrying the gold and silver is converted into "blister" and shipped to the Baltimore Copper Smelting & Rolling Co., at Baltimore, Md. Some copper cement is produced from the mine water by precipitation on scrap iron. The smelter was in operation the entire year. Also at Keswick is the productive mine of the Pittsburg & Mount Shasta Gold Mining Co., developed by an adit of 2,500 feet, a shaft of 300 feet, and about 1,500 feet of drifts. The Mariana Marsicano mine at Ono is a small producer. At Knob (Harrison Gulch district) the Midas is one of the large producers of the county. It is developed by a 1,300-foot adit, 1,000-foot main shaft, 490-foot secondary shaft, and underground shafts of 185 and 125 feet, respectively. In 1912 development work consisted of 1,040 feet of crosscuts, 1,280 feet of drifts, and 400 feet of raises. There are a few small producing mines near Redding.

The Bully Hill smelter at Winthrop continues closed down, but experiments are being conducted for the utilization of the zinc-bearing ores of the mine. The Balaklala copper mine at Coram (Iron Mountain district) also still remains idle through fume litigation, but steps are being taken to make it again productive.

Among the nonproducers in Shasta County, the Delta Consolidated Mining Co., at Bayles, owning a group of 30 claims on Dog Creek, continued development through the year. The Highland Mining & Tunnel Co., at French Gulch started the new Standard tunnel and put up a small mill which did not begin to operate until May, 1913. The Yosemite Investment Co. devoted time in 1912 to prospecting certain dredging ground. The placer mines of the county which were more or less productive in 1912 were the Lone Wolf, at Bayles; Rice and Slattery & Welch, at French Gulch; Shasta Dredging, at Larkin; and Big Boulder, at Lamoine.

SIERRA COUNTY.

The total production of Sierra County in 1912 was valued at $735,765, as compared with $467,117 in 1911, an increase of $268,648. Of the total increase $271,475 was in gold, the silver value having decreased by $2,827. The yield of the county in 1912 was 35,458.29 fine ounces of gold, valued at $732,988, and 4,515 ounces of silver, valued at $2,777. There were 76,606 tons of siliceous ore treated, yielding 29,822.46 fine ounces of gold, valued at $616,485, and 3,878 ounces of silver, valued at $2,385, a total of $618,870 from the deep mines. The gold output from the placers was 5,635.83 fine ounces, valued at $116,503, and 637 ounces of silver, valued at $392, a total of $116,895. Of this placer gold, $78,779 came from 10 hydraulic mines, $34,237 from 13 drift mines, and $3,487 from 6 surface or sluicing mines. There were 54 productive mines, 25 of which were deep gold mines. There were 62 producing mines in 1911. The deep mines in 1912 produced $499,982 in gold more than the placers, those deep mines increasing their yield in 1912 by $358,750 more than in 1911, showing that the quartz mines of the county are doing much better than they were. At Alleghany the quartz mines produced in gold $293,561 from 18,389 tons of ore, as compared with $113,675 in gold from 10,350 tons in 1911. From the deep mines of this camp alone, therefore, there was an increased gold yield amounting to $179,886 in 1912. The largest two producers at Alleghany are the Tightner and the Crœsus (Plumbago). The Tightner, now owned by a company of which A. D. Foote, of the North Star Mines Co., of Grass Valley, Nevada County, is president, is opened by a main tunnel 1,800 feet to the vein and 2,000 feet on the vein, with raises and stopes above 1,500 feet. The concentrates from the ore mined in 1912 were stocked for future working. Other producing mines at Alleghany are the Kenton, Rainbow, and "16 to 1," or Bonanza King. The Brandy City Mining Co. is the only producer at Brandy City. At Downieville the deep-mine producers are the Mexican, Sierra Standard, Stone, Willoughby, and Sovereign mines, with a combined output of gold in 1912 of $8,355. A small output from an old dump was all that was derived from the Kate Hardy at Forest. The Four Hills Mining Co., the nearest post office to which is Johnsville, Plumas County, did not operate the mine itself, but a considerable output was made by a lessee. The Sierra-Alaska (Pike) Mining Co., at Pike, reported quite a large output for the year. At Sierra City the following deep mines are productive: Cleveland, Gold Coin, Keystone, Phœnix Buttes, Sacred Mound, and Sierra Buttes. The Keystone was being developed under bond. Concentrators, larger compressor, and electric generator may be installed.

Of the placer mines the most important producer in the county is the Brandy City, of Brandy City, a hydraulic mine. Next in importance in point of product is the Monte Cristo, of Downieville, a drift mine. Other placers productive in 1912 are the Depot Hill and Wyncook, near Camptonville, Yuba County; Bacon, Excelsior, Soldier Boy, Secret Canyon, Telegraph, and White Bear, at Downieville, with a combined gold output of $27,138; Morristown and Quartz Hill, at La Porte; Neocene, at Scales; Big Canyon, Burlington, Ladies Canyon, Last Resort, and Noonday, at Sierra City; Caledonia at St. Louis; and a few small mines at Table Rock.

SISKIYOU COUNTY.

In 1912 Siskiyou County produced 20,811.80 fine ounces of gold, valued at $430,218, and 4,557 ounces of silver, valued at $2,803, a total of $433,021, as compared with $424,858 in 1911, and an increase in total value of $8,163. The 37 deep mines of the county, all gold, yielded, from 13,160 tons of ore, 9,213.99 fine ounces of gold, valued at $190,470, and 2,582 ounces of silver, valued at $1,588, a total of $192,058, as compared with $105,618 in 1911. The 75 producing placers yielded 11,597.81 fine ounces of gold, valued at $239,748, and 1,975 ounces of silver, valued at $1,215, a total of $240,963, as compared with $319,240 in 1912. The placers thus yielded $48,905 more than the deep mines in 1912, although their total output was $78,277 less than in 1911. There were 112 producing mines, including placer and deep mines, in Siskiyou County in 1912, which is 27 more than in any other county in the State, but 42 less than in 1911. Of the placers in Siskiyou County, the 51 hydraulic mines produced $217,043 in gold, the 6 drift mines $9,181, and the 17 surface placers $13,524, a total of $239,748. The output of one dredge in the county is eliminated from the placer total and included in the combined figures of Merced, Shasta, Siskiyou, and Stanislaus counties, in order to conceal individual output. The drift-mine gold output increased by $2,636 in 1912 as compared with 1911; the hydraulic-mine output decreased by $536; and the gold output from surface placers was $4,509 more in 1912 than in 1911. There are no Federal restrictions affecting hydraulic mining in Siskiyou County as there are in the central mining counties of the State.

The deep mines at Callahan made a combined gold production of $31,864 in 1912. These were the Adeline Ricks, Bouvier, Eaton, Gold Dike, Trail Creek, and Porphyry Dike. The Condemned, at Cecilville, was a small producer. At Etna Mills the producers were the Keating mine of the Siskiyou Syndicate, and the Highland mine of the Mijnbouw Maatschappij, of The Hague, Holland. The De Mure & Burton, the Sheba, and the Weeks are at Fort Jones. The Gold Run, at Gilta; Gipsy, at Hawkinsville; and Sunnyside, at Hilts, are small producers. The Hazel, at Henley, is the most productive of the deep mines of the county. The China Gulch, Indian Girl, Mattern, Moon, and La Flesh, at Hornbrook, made a combined gold output of $15,482 in 1912. The Eureka and W. Y. O. D., at Robbins; Gold Hill and Dunphy, at Sawyers Bar; Kelsey, at Seiad Valley; and Lanky Bob, at Snowden, were all small producers. The Columbia-Mabel claims, at Scott Bar, were worked productively by lessees, the ore coming from the Mabel mine. At Yreka the Cliff & Lucky Strike, Inyo, Wacker, Suable, and Le May only made a combined gold output of $6,143.

Of the placers, the largest gold producer is the Siskiyou Dredge Co., Fort Jones. Others among the large producers are the Bloomer, at Forks of Salmon; Red Hill, at Black Bear; Weed, at Greenview; Siskiyou, at Happy Camp; Forks of Salmon River, at Sawyers Bar; Ten Eyck, at Seiad—all hydraulic mines; and Lucky Bob (drift), at Gottville.

Of the principal placer districts in Siskiyou County in 1912 the mines at or near Black Bear produced $15,486 in gold; Callahan, $3,398; Cecilville, $7,408; Forks of Salmon, $18,510; Fort Jones, $56,552; Gottville, $7,487; Greenview, $13,326; Hamburg, $14,587;

Happy Camp, $23,278; Hilts, $3,775; Oak Bar, $3,400; Sawyers Bar, $61,459; Scott Bar, $4,869· Seiad Valley, $3,159; and Walker, $6,450.

TRINITY COUNTY.

In 1912 Trinity County produced 34,999.45 fine ounces of gold, valued at $723,503, and 12,185 ounces of silver, valued at $7,494, a total of $730,997, which is $112,071 more than the total in 1911 and $228,186 more than the total in 1910—an indication that the mining industry in the county is in a growing condition. There were 85 productive mines in the county in 1912, of which 26 were deep gold mines and 59 placers of various kinds. The deep mines produced 57,307 tons of ore, which yielded 12,449.64 fine ounces of gold, valued at $257,357, and 9,478 ounces of silver, valued at $5,829, a total of $263,186, as compared with $303,339 in 1911 and with $127,628 in 1910. The 59 placers yielded 22,549.81 fine ounces of gold, valued at $466,146, and 2,707 ounces of silver, valued at $1,665, a total of $467,811, as compared with $315,587 in 1911. The placer mines thus increased their output in 1912 by $152,224, while the total output of the deep mines decreased by $40,153. The 41 hydraulic mines produced $274,239 in gold; the dredges, $174,532; the 4 drift mines, $2,881; and the 12 surface placers, $14,494. In hydraulic mining Trinity County stands first among the counties of the State, the largest hydraulic mine in the United States, the La Grange, being in the county. In Trinity County, as in Siskiyou County, there are no restrictions requiring the impounding of the mining débris, as these counties are outside the drainage basins of Sacramento and San Joaquin rivers, where the Government restriction applies to this character of gravel mining.

The principal deep mine of the county is the Headlight, owned by the Trinity Gold Mining & Reduction Co., at Carrville. The mine is worked through an open cut, or "glory hole," opened by drifts, raises, and crosscuts. The property has a 250-ton cyanide plant, and the process of treatment of the ore has been by cyanidation (leaching and slime treatment), the base bullion being sold to the Selby Smelting & Lead Co. The mill was shut down in August, 1912, sulphide ore not amenable to cyanide treatment reported to be replacing gossan. At the Blue Jay "pocket" mine the gold is found in pockets or bunches in small seams or veins, and generally embedded in manganese. The vein matter, clay, and manganese constitute the ore for the milling plant. There is no quartz in the mine, and as the gold is found in large pieces the milling plant is of secondary importance to hand sorting. The largest rough piece of gold recovered during the lease in 1912 weighed 66 ounces. In addition to these two mines the Golden Eagle, Deer Lick, Rams Horn, and Golconda Consolidated are at Carrville, from which camp the yield of gold in 1912 was $177,389. At Coffee are the Battle Peak, Gold Ridge, and Mule, with a combined yield of $2,026. At Deadwood are the Brown Bear and the Readjuster mines. The Brown Bear is an old mine, opened by tunnels, the longest of which is 5,000 feet. The Globe mine, at Dedrick, has been sold to the Globe Consolidated Mines Co. The Boomer mine, at Denny, and the Dixie Queen and Oriole, at Douglas City, were small producers. The Enterprise and Yellowstone groups are at Helena.

Other small producers are the Blue Jay and the Last Chance, at Lewiston; the Fairview, at Minersville; and the Supplanter and the Quinby, at Quinby. Considerable gold was taken out of old tailings of the Bonanza King at Trinity Center, and there was a considerable production from the Five Pines mine at the same place. The total yield in deep-mine gold at Trinity Center was $24,338.

Of the placers of Trinity County the most productive is that of the Altabert Dredging Co., at Trinity Center, this being the first instance in the history of the county that a gold-dredging operation has exceeded in yield a hydraulic mine, such as the La Grange Mining Co., near Weaverville. Other placers of importance are the Big East Fork hydraulic, at Dedrick; Browns Ranch hydraulic, Trinity Consolidated hydraulic, at Douglas City; Chapman hydraulic, at Junction City; Trinity Dredging Co., at Lewiston; Sykes hydraulic, at Trinity Center; and Five Cent mine of the Trinity Consolidated Hydraulic Mining Co., at Weaverville. The mining district embracing the placer mines around Big Bar produced $5,620 in gold in 1912; at Burnt Ranch, $955; at Coffee, $3,241; at Dedrick, $4,735; at Douglas City, $41,529; at Junction City, $18,828; at Lewiston, $16,971; at Minersville, $906; at Quinby, $5,051; at Trinity Center, $175,824; and at Weaverville, $187,121.

TUOLUMNE COUNTY.

Number of mines producing in Tuolumne County, Cal., quantity of ore sold or treated in 1905–1912, and total gold, silver, and lead.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1905	43	303,631	$1,298,888	19,076	.....	$1,310,410
1906	34	278,618	1,039,675	12,651	.....	1,048,151
1907	40	194,209	806,876	9,778	6,000	813,647
1908	50	263,216	798,752	22,136	.....	810,484
1909	53	288,618	925,703	8,430	.....	930,087
1910	43	197,737	615,626	10,655	.....	621,380
1911	63	308,652	1,093,484	24,987	.....	1,106,727
1912	53	228,823	1,113,291	40,888	.....	1,138,437
Increase (+) or decrease (−)	−10	−79,829	+19,807	+15,901	.....	+31,710

In Tuolumne County in 1912 there was a decrease in number of productive mines and in tonnage of ore mined and treated, but the value of the total output of the county increased by $31,710. The county mines produced 53,855.46 fine ounces of gold, valued at $1,113,291, and 40,888 ounces of silver, valued at $25,146, a total of $1,138,437 in gold and silver, as compared with $1,106,727 in 1911. There were 53 producing mines in the county in 1912, of which 49 were deep gold mines and 4 were drift mines. The combined production of these placers was $6,039 in gold and 37 ounces of silver, valued at $23, a total of $6,062.

The ore sold or treated in the county in 1912 amounted to 228,823 tons, of which 1,515 tons were old tailings. The 227,308 tons treated at the gold and silver mills yielded in bullion $814,431 in gold, an average of $3.58 per ton, and 34,011 ounces of silver, valued at $20,917, an average of $0.09 per ton, a total saved in mill bullion valued at $835,348, or an average of $3.67 per ton in gold and silver.

From this milling ore 7,974 tons of concentrates were obtained, which yielded $291,024 in gold, an average of $36.50 per ton, and 6,832 ounces of silver, valued at $4,202, an average of $0.54 per ton, a total of $295,226 in gold and silver, and a total average yield of $37.04 per ton in gold and silver.

The ore milled and concentrated yielded a total of $1,105,455 in gold, an average of $4.83 per ton, and 40,843 ounces of silver, valued at $25,819, or $0.11 per ton. The total yield of gold and silver on the plates and from the concentrates was valued at $1,131,274, an average yield of $4.94.

The 1,515 tons of tailings yielded $1,797 in gold and 8 ounces of silver, valued at $5, a total yield of $1,802.

The most productive mine in the county was that of the Black Oak Development Co., at Soulsbyville.[1] At the Black Oak the ore is treated by direct cyanidation and the milling costs reduced to $1.729 per ton in 1912. At Big Oak Flat the Maxwell, Mearta, Nonpareil, Little Sisters, Oro Fino, and Poco Tempo mines made a combined gold output of $12,158. The Bronx, Ethel, and Experimental Gulch, at Columbia, made a combined output of gold of $4,749 only. The Gem and the Morning Glory are small producers at Confidence, as is the Cosmopolite at Groveland. At Jacksonville are the Imperial, Mammoth, and Orr mines. The Harvard Mine (Inc.), one of the largest producers in the county, is at Jamestown. The Dutch Consolidated, Mann, App (of the Rawhide Gold Mining Co.), and Santa Ysabel are at Quartz, and made a combined gold output of $191,471. The operators of the Dutch Consolidated put in a new sawmill in 1912, added 20 stamps to the mill, making 40 in all; the electric hoist, new compressor, drill sharpeners, and all machinery is now run by electric power. The Eagle Shawmut Mining Co., of Shawmut, has a 100-stamp mill and one of the two chlorination plants in the State. Owing to shortage of water for the power plant, the property was only operated seven months in 1912. The mine is opened by an 1,800-foot deep incline shaft and an incline winze 600 feet below this. At Sonora the Belmont, Davis, Harris, Sell, Stonewall, and Sugarman mines made a combined gold output of $65,281. The Draper, at Soulsbyville, made a small output. The Jumper California, at Stent, is opened by a 1,400-foot incline shaft and 450-foot winze.

At Tuolumne City are the Pennsylvania, Dreisam, Rose Spring, Richards, Providence, Star King, and United Mines Corporation, which made a combined gold output of $33,104. There are only a few small producing mines at Tuttletown.

YUBA COUNTY.

In 1912 Yuba County, after having held the highest rank among the counties of the State for two years in point of gold production, dropped to second place, giving precedence to Amador County. The output of Yuba County in 1912 was 133,196.11 fine ounces of gold, valued at $2,753,408, and 10,078 ounces of silver, valued at $6,198, a total of $2,759,606, as compared with $3,002,371. The

[1] Min. and Sci. Press, Nov. 30, 1912, pp. 687–692; Eng. and Min. Jour., June 13, 1913, pp. 1179–1181.

decrease in gold for 1912, as compared with 1911, was $243,664. The decrease in gold output from dredging operations was $248,540, but there was an increase in output of this metal from deep and drift mining in the county. There were 14 dredges in operation during 1912 and 13 in 1911. There were 25 placer mines operating in the county in 1912, of which 14 were dredges, 1 a drift mine, and 10 sluicing mines. There were also 4 deep mines which were productive. The Yuba Consolidated Goldfields on the Yuba River at Hammonton had 11 dredges in operation to June,1912, and 10 from that time until December. One dredge of a new company was operated only a part of the year, and then ceased work entirely. The Marysville Gold Dredging Co., near Marysville, worked 2 dredges the entire year. Only a few small placers are being worked now at Smartsville, formerly a celebrated hydraulic mining center. There are also several small placers at Brownsville and Browns Valley. The few deep mines of the county are at Brownsville and Dobbins, these being the Apple Tree, at Brownsville, and the Good Title, Red Cross, and Red Ravine, at Dobbins, of which the Red Cross is the most productive.

OTHER COUNTIES.

Alpine, Monterey, and San Luis Obispo counties each made a small production in 1912. Alpine County shows returns of $1,764 in gold and 2,300 ounces of silver, valued at $1,415, a total of $3,179 from one mine only.

Monterey shows production from 4 mines, of which 3 were deep gold mines and 1 was a placer. The last is a small placer near Jolon, and the deep mines are the Holly Berry, at Gorda; the Green Gold and the Jolon mines at Jolon. The total output of the county was $3,458, of which $3,435 was gold.

San Luis Obispo County reported yield from 3 small placers at Pozo, all sluicing properties, the total being $976 in gold, and 8 ounces of silver, valued at $5.

COLORADO.

By Charles W. Henderson.

PRODUCTION.

The total value of the production of gold, silver, copper, lead, and zinc in Colorado in 1912, as reported from 856 mines, 33 of which were placers, amounted to $37,320,966, as compared with $32,418,218 in 1911, an increase for 1912 of $4,902,748. Of the total value, 49.8 per cent represented gold, which was valued at $18,588,562, a decrease of $413,413 as compared with the yield of 1911. There was an increase in silver output of 881,902 fine ounces. The production of copper, which is mainly incidental to the recovery of other metals, decreased 917,185 pounds. The tonnage of true copper ores decreased materially. The quantity of copper in the dry ores of Gilpin, San Juan, Saguache, Chaffee, and Hinsdale counties increased, while that in the dry ores of Lake, San Miguel, Ouray, and Clear Creek counties decreased, the combined production showing a considerable net decrease. The quantity of lead produced in 1912 was 75,242,267 pounds, an increase of 5,562,978 pounds. The tonnage of true lead ores increased. The quantity of zinc produced was 132,222,812 pounds, an increase of 37,615,356 pounds.

ORE PRODUCTION IN 1912.

The output of ore sold or treated in 1912 from Colorado mines was 2,576,626 short tons, an increase of 198,690 tons as compared with the output of 1911.

The output of siliceous or dry ores was 1,966,300 tons, an increase of 92,197 tons. The average content of dry or siliceous ores was 0.428 ounce gold and 2.75 ounces silver per ton, 0.10 per cent copper and 0.51 per cent lead.

The output of copper ores was 13,718 tons, a decrease of 4,503 tons; the production of lead ores was 182,745 tons, an increase of 23,761 tons; and the output of zinc ores increased from 110,845 tons in 1911 to 177,946 tons, an increase of 67,101 tons. There were 6,810 tons of copper-lead ores produced in 1912, an increase of 5,412 tons. The output of lead-zinc ores was 229,107 tons, an increase of 14,722 tons. The combined output of zinc and lead-zinc ores showed an increase of 81,823 tons.

The average content of copper ores was 0.639 ounce gold and 16.35 ounces silver per ton, 5.91 per cent copper and 0.37 per cent lead.

During 1912 there were treated at amalgamating, cyaniding, or chlorinating mills, with or without concentration equipment (including all the custom mills in the State), 1,435,837 tons of ore, with an average recovery as bullion or precipitates of 0.379 ounce gold and 0.25 ounce silver per ton.

From the 1,435,837 tons treated at amalgamating, cyaniding, or chlorinating mills, and from 523,063 tons sent to concentration and separation mills, a total to both classes of mills of 1,958,900 tons (76 per cent of the total tonnage treated, as compared with 77 per cent in 1911), were produced 224,722 tons of concentrates—ratio 8.7 to 1—with an average total value of $44.24 per ton, as compared with $38.68 in 1911.

Ore milled in 1912, in terms of metals recovered as bullion or by concentration, averaged 0.346 ounce gold and 1.42 ounces silver per ton, 0.07 per cent copper and 1.18 per cent lead.

Crude ore shipped to all kinds of smelters amounted to 617,726 tons, averaging 0.312 ounce gold and 8.78 ounces silver per ton, 0.36 per cent copper and 2.36 per cent lead.

Crude ore and concentrates shipped to all kinds of smelters, therefore, amounted to 842,448 tons, averaging 0.388 ounce gold and 9.31 ounces silver per ton, 0.42 per cent copper and 4.47 per cent lead.

In 1912 there were 33 productive placers in Colorado, which yielded $423,885 in gold, and 5,106 fine ounces, valued at $3,140, in silver, a total of $427,025 in gold and silver, as compared with $321,704 in 1911, with $398,140 in 1910, with $461,508 in 1909, and with $186,058 in 1908.

The statement of Colorado production from 1904 to 1912, showing increase or decrease of 1912 over 1911, and total value at each year's commercial price, is as follows:

Production of gold, silver, copper, lead, and zinc in Colorado, 1904–1912.[a]

Year.	Number of producing mines.	Tonnage.	Gold.[b]	Silver.[b]	Copper.	Lead.	Zinc.	Total value.	Average total value per ton.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	578	2,333,881	$24,463,322	13,947,635	9,435,962	102,792,782	101,016,774	$43,175,775	$17.89
1905	513	2,504,087	25,023,973	11,499,307	9,404,830	111,585,060	83,150,445	43,587,081	17.37
1906	664	2,648,923	23,210,629	12,216,830	5,720,929	104,102,269	86,965,308	43,738,757	16.51
1907	642	2,383,128	20,826,194	11,229,776	7,724,590	85,406,849	52,788,326	37,423,838	15.67
1908	667	2,243,891	22,300,627	8,905,433	9,997,738	52,200,130	30,130,002	31,948,722	14.16
1909	925	2,219,741	21,989,336	8,902,633	10,922,046	72,167,790	51,210,260	33,907,140	15.07
1910	898	2,434,664	20,507,058	8,509,598	8,359,535	76,071,273	77,089,648	33,673,879	13.67
1911	861	2,377,936	19,001,975	7,330,168	8,024,488	69,679,289	94,607,456	32,418,218	13.08
1912	856	2,576,626	18,588,562	8,212,070	7,107,303	75,242,267	132,222,812	37,320,966	14.32
Increase (+) or decrease (−)	−5	+198,690	−413,413	+881,902	−917,185	+5,562,978	+37,615,356	+4,902,748	+1.24

[a] United States Geological Survey figures, as calculated from reports from the mines.
[b] Includes placer production.

GOLD.

The total gold production for Colorado in 1912 was 899,221.69 fine ounces, valued at $18,588,562, as against 919,220.54 fine ounces, valued at $19,001,975 in 1911, a decrease of 19,998.85 fine ounces in quantity and of $413,413 in value.

The Cripple Creek district, with an increase of $445,709, produced $11,008,362 in gold, which was 59 per cent of the Colorado gold output from all sources and 60.6 per cent of the gold from deep mines.

The San Juan region, in Dolores, La Plata, Ouray, San Juan, and San Miguel counties, showed a decrease of $916,419, Ouray County alone showing a decrease of $903,368. There was also a decrease of $151,546 from La Plata County, but an increase of $187,111 from San Juan County. Other counties showing an increased output of gold were Chaffee, Gilpin, Eagle, Park, and Summit.

Siliceous and dry ores, which made 76 per cent of all the tonnage mined, yielded 841,295.86 fine ounces, valued at $17,391,129, or nearly 94 per cent of all the gold production. A little more than 2 per cent came from lead ores, nearly 1 per cent came from copper ores, less than 1 per cent from copper-lead ores, and nearly 1 per cent from zinc and lead-zinc ores. A little over 2 per cent came from placers.

The output of placer gold in 1912 was 20,505.44 fine ounces, valued at $423,885, an increase of $104,126. Summit County, with 3 dredges and 8 placers, produced nearly 93 per cent of the placer yield. The greater part of the remainder came from sluicing operations in Park, Chaffee, and Moffat counties. There were small placer yields in Clear Creek, Costilla, Douglas, Eagle, Gunnison, Montrose, and Routt counties.

Source of gold production in Colorado in 1912, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Boulder		5,533.02	2.99	241.22				5,777.23
Chaffee	223.44	138.48	2.80	4,343.07		1.68	6.56	4,716.03
Clear Creek	16.01	18,427.97	35.62	1,375.73		1,136.25	573.70	21,565.28
Costilla	22.74							22.74
Custer		816.97	.21	.26				817.44
Dolores		320.68	34.34	7.36			3.14	365.52
Douglas	3.64							3.64
Eagle	.96	1,872.87	173.63	254.43			82.70	2,384.59
Fremont						12.24		12.24
Gilpin		37,332.23	6,075.05	313.00		35.15		43,755.43
Gunnison	31.48	5,997.26		28.95		3.33	1.67	6,062.69
Hinsdale		116.28	4.76	204.72		3.72		329.48
Lake		42,473.10	2,136.03	6,593.46	513.48	16.81	1,635.87	53,368.75
La Plata		6,546.90		2.64				6,549.54
Mesa			.43					.43
Mineral		837.82					3,322.53	4,160.35
Moffat	214.39							214.39
Montrose	33.24							33.25
Ouray		50,189.45	5.57	359.83		165.10	53.97	50,773.92
Park	929.93	371.51		1,976.31	4.66	.20	5.97	3,288.58
Pitkin		7.35		.63				7.98
Rio Grande			268.47					268.47
Routt	30.86							30.86
Saguache		77.17	15.23	23.86		1.62	66.19	184.07
San Juan		21,424.60	1.40	3,020.57		560.49	320.83	25,327.89
San Miguel		115,971.10		91.84				116,062.94
Summit	18,998.75	311.58	3.33	928.93	14.37		351.51	20,608.47
Teller		532,529.51						532,529.51
Total, 1912.	20,505.44	841,295.84	8,759.86	19,766.81	532.51	1,936.59	6,424.64	899,221.69
Total, 1911.	15,468.34	866,252.76	8,472.08	17,765.42	164.54	882.05	10,215.35	919,220.54
Increase (+) or decrease (−).	+5,037.10	−24,956.92	+287.78	+2,001.39	+367.97	+1,054.54	−3,790.71	−19,998.85

SILVER.

The silver yield in 1912 was 8,212,070 fine ounces, valued at $5,050,423, as against 7,330,168 fine ounces, valued at $3,884,989 in 1911, an increase of 881,902 fine ounces in quantity and of $1,165,434 in value.

Lake County showed for 1912 a decrease of 6,899 ounces, but the output was 37 per cent of the State yield, as compared with 41 per cent in 1911, with 39 per cent in 1910, and with 38 per cent in 1909. Decreases of note were in La Plata and Clear Creek counties. Notable increases in output of silver were shown in San Juan, Mineral, and San Miguel counties.

In the production of silver 8 counties, ranking in the order named, Lake, San Miguel, San Juan, Mineral, Ouray, Pitkin, Clear Creek, and Gilpin, furnished 89 per cent of the total.

Siliceous or dry ores yielded 5,397,439 fine ounces, or nearly 66 per cent of the silver output; lead ores, 1,470,930 ounces, or nearly 18 per cent; lead-zinc ores, 594,427 ounces, or 7 per cent; copper-lead ores, 389,449 ounces, or over 5 per cent; copper ores, 224,327 ounces, or nearly 3 per cent; zinc ores, 130,392 ounces, or nearly 2 per cent. A negligible percentage came from placers.

Source of silver production in Colorado in 1912, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Boulder	.....	55,413	9	16,913	.....	.....	.....	72,335
Chaffee	39	6,892	1,292	92,185	36	3,565	677	104,686
Clear Creek	.....	171,913	272	92,086	.....	28,662	81,007	373,940
Costilla	3	.....	.....	.....	.....	.....	.....	3
Custer	.....	24,052	475	899	.....	.....	.....	25,426
Dolores	.....	28,819	31,870	20,488	.....	.....	19,111	100,288
Eagle	.....	39,907	3,608	110,619	.....	.....	9,601	163,735
Fremont	.....	.....	.....	.....	1,644	1,795	.....	3,439
Gilpin	.....	270,419	35,388	9,231	.....	1,167	.....	316,205
Gunnison	27	17,704	.....	328	.....	1,964	9,012	29,035
Hinsdale	.....	10,778	1,522	21,339	.....	1,083	.....	34,722
Lake	.....	1,938,285	144,227	452,206	128,290	2,285	335,104	3,000,397
La Plata	.....	47,105	.....	843	.....	.....	.....	47,948
Mesa	.....	.....	257	.....	.....	.....	.....	257
Mineral	.....	677,569	.....	.....	.....	.....	37,340	714,909
Moffat	10	.....	124	.....	.....	.....	.....	134
Montrose	10	.....	.....	.....	.....	.....	.....	10
Ouray	.....	441,693	2,178	87,932	.....	9,638	3,736	545,177
Park	189	19,849	.....	9,717	70	1,159	250	31,234
Pitkin	.....	229,401	.....	298,224	.....	.....	879	528,504
Rio Grande	.....	.....	896	.....	.....	.....	.....	896
Routt	16	.....	.....	.....	.....	.....	.....	16
Saguache	.....	7,784	12	1,983	.....	142	9,388	19,309
San Juan	.....	244,799	2,120	117,420	.....	337,989	12,646	714,974
San Miguel	.....	1,064,302	.....	89,407	.....	.....	.....	1,153,709
Summit	4,812	34,638	77	49,110	352	.....	75,676	164,665
Teller	.....	66,117	.....	.....	.....	.....	.....	66,117
Total, 1912	5,106	5,397,439	224,327	1,470,930	130,392	389,449	594,427	8,212,070
Total, 1911	3,669	5,096,026	342,550	1,265,594	55,969	90,311	476,049	7,330,168
Increase (+) or decrease (−)	+1,437	+301,413	−118,223	+205,336	+74,423	+299,138	+118,378	+881,902

COPPER.

The copper output in 1912 decreased in quantity from 8,024,488 pounds to 7,107,303 pounds, but increased in value from $1,003,061 to $1,172,705. Copper production was reported from 23 counties in 1912.

As usual, Lake County was the leading copper producer, yielding 29 per cent of the State output in 1912; San Juan was second, with 15 per cent, followed closely by Gilpin, with 14 per cent. San Miguel, Dolores, Clear Creek, and Ouray counties followed in order. These 7 counties, combined, produced 92 per cent of the total.

Siliceous or dry ores yielded 4,196,096 pounds, or 59 per cent, of the copper output; copper ores, 1,622,605 pounds, or nearly 23 per cent; lead ores, 539,216 pounds, or nearly 8 per cent; copper-lead ores, 531,227 pounds, or over 7 per cent; lead-zinc ores, 151,147 pounds, or 2 per cent; zinc ores, 67,012 pounds, or nearly 1 per cent.

Source of copper production in Colorado in 1912, by kinds of ore, by counties, in pounds.

County.	Dry or siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	14,893	616	6,667	.....	.....	.....	22,176
Chaffee	5,006	59,958	51,779	785	15,978	64	133,570
Clear Creek	304,714	1,850	25,807	.....	94,685	22,345	449,401
Custer	220	1,251	535	.....	.....	.....	2,006
Dolores	448	688,707	368	.....	.....	392	689,915
Eagle	28,386	25,030	93,632	.....	.....	128	147,176
Fremont	.....	.....	.....	21,418	14,485	.....	35,903
Gilpin	736,061	282,773	2,061	.....	4,875	.....	1,025,770
Gunnison	1,934	.....	84	.....	4,920	1,159	8,097
Hinsdale	2,143	9,503	34,637	.....	7,456	.....	53,739
Lake	1,421,561	471,437	36,913	44,710	4,650	86,529	2,065,800
La Plata	811	.....	107	.....	.....	.....	918
Mesa	.....	5,685	.....	.....	.....	.....	5,685
Mineral	13,039	.....	.....	.....	.....	10,846	23,885
Moffat	.....	25,085	.....	.....	.....	.....	25,085
Ouray	350,381	14,849	10,546	.....	20,281	4,495	400,552
Park	645	.....	7,966	99	1,370	241	10,321
Pitkin	934	.....	22,018	.....	.....	.....	22,952
Rio Grande	.....	29,673	.....	.....	.....	.....	29,673
Saguache	18,827	471	2,109	.....	988	7,084	29,479
San Juan	476,516	5,445	206,297	.....	361,539	13,494	1,063,291
San Miguel	819,086	.....	26,411	.....	.....	.....	845,497
Summit	491	272	11,279	.....	.....	4,370	16,412
Total, 1912	4,196,096	1,622,605	539,216	67,012	531,227	151,147	7,107,303
Total, 1911	5,614,076	1,652,247	492,422	11,883	93,025	160,835	8,024,488
Increase (+) or decrease (−)	−1,417,980	−29,642	+46,794	+55,129	+438,202	−9,688	−917,185

LEAD.

The lead production in Colorado in 1912 was 75,242,267 pounds, valued at $3,385,902, as against 69,679,289 pounds, valued at $3,135,568 in 1911, an increase of 5,562,978 pounds in quantity and of $250,334 in value.

There were marked increases in San Juan, Lake, Hinsdale, Dolores, and Eagle counties. Decreases of note were made in Pitkin, Mineral, Summit, Ouray, Park, and Gunnison counties.

In rank, Lake County led, with 26,234,244 pounds; San Juan was second, with 9,114,334 pounds; Pitkin was third, with 8,405,333 pounds; San Miguel was fourth, with 7,429,622 pounds; Mineral was fifth, with 5,730,222 pounds; Summit was sixth, with 4,402,422

pounds; Clear Creek was seventh, with 3,523,733 pounds; and Ouray, Gilpin, Hinsdale, and Eagle followed in order. There was an increase of 23,761 tons in the tonnage of lead ores produced and an increase of 14,722 tons in that of lead-zinc ores. Siliceous or dry ores yielded 20,162,526 pounds, or nearly 27 per cent of the lead output; lead ores, 29,640,633 pounds, or over 39 per cent; lead-zinc ores, 22,841,286 pounds, or over 30 per cent; zinc ores, 1,235,019 pounds, or a little more than 1 per cent; copper and copper-lead ores combined, 1,362,803 pounds, or over 1 per cent.

Source of lead production in Colorado in 1912, by kinds of ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	21,919	53	283,850				305,822
Chaffee	8,630	15,415	851,691	1,096	105,701	10,045	992,578
Clear Creek	573,784		1,076,907		548,784	1,324,258	3,523,733
Custer	8,178	269	1,997				10,444
Dolores	8,045	866	560,772			642,717	1,212,400
Eagle	1,598	94	681,941			556,523	1,240,156
Fremont				31,419	24,537		55,956
Gilpin	1,131,520	18,363	192,468		9,249		1,351,600
Gunnison	165,586		3,531		5,625	132,125	306,867
Hinsdale	7,199	1,805	1,219,490		29,306		1,257,800
Lake	3,802,920	62,486	10,208,645	1,201,622	6,757	10,951,814	26,234,244
La Plata	4,555		2,201				6,756
Mesa		20					20
Mineral	1,374,856					4,355,366	5,730,222
Ouray	2,166,481	1,061	750,333		27,363	43,806	2,989,044
Park	4,437		146,979	882	2,985	12,473	167,756
Pitkin	161,996		8,215,165			28,172	8,405,333
Rio Grande		313					313
Saguache	26,815		47,849		9,277	420,904	504,845
San Juan	4,191,700	1,576	3,588,519		490,898	841,641	9,114,334
San Miguel	6,440,756		988,866				7,429,622
Summit	61,551		819,429			3,521,442	4,402,422
Total, 1912	20,162,526	102,321	29,640,633	1,235,019	1,260,482	22,841,286	75,242,267
Total, 1911	18,724,095	67,700	26,466,369	407,007	326,521	23,687,597	69,679,289
Increase (+) or decrease (−)	+1,438,431	+34,621	+3,174,264	+828,012	+933,961	−846,311	+5,562,978

ZINC.

In 1912 the marketed zinc ores from Colorado contained 132,222,812 pounds of zinc (figured as spelter and zinc in zinc oxide), valued at $9,123,374, as compared with 94,607,456 pounds, valued at $5,392,625, in 1911, with 77,089,648 pounds, valued at $4,162,841, in 1910, and with 51,210,260 pounds, valued at $2,765,354, in 1909. In 1912, the quantity of zinc yielded was 56,980,545 more pounds than that of lead, and the value was $5,737,472 more than the value of lead and $4,072,951 more than the value of silver.

Zinc ores furnished 84,989,652 pounds, or 64 per cent of the total zinc yield; lead-zinc ores, 42,678,285 pounds, or 32 per cent; and siliceous or dry ores, 4,554,875 pounds, or over 3 per cent.

Lake County produced 80 per cent of the zinc yield of the State, with an output of 105,945,783 pounds, an increase of 34,335,337 pounds for the year. Leadville zinc carbonate shipments, which were only 83,905 tons of 31 per cent zinc in 1911, amounted to 142,782 tons of 29.2 per cent zinc in 1912; the tonnage of zinc sulphide increased from 79,376 tons of 23.3 per cent zinc in 1911, to 104,148 tons of 24 per cent zinc in 1912.

Increased production of zinc was also made in Chaffee, Clear Creek, Dolores, Eagle, Fremont, Ouray, Pitkin, Saguache, San Juan, and Summit counties, and appreciable decreases were made in Mineral, Park, and San Miguel counties. After Lake County, Summit and Eagle counties are respectively second and third in the output of zinc.

Zinc output from concentrates in 1912 amounted to 46,053,954 pounds and in crude ore shipped direct to 86,168,858 pounds.

The following tables show the tonnages of zinc ore and concentrates from a market standpoint:

Zinc ore and concentrates as marketed at the mine or mill, in Colorado, in 1912, by counties and districts, in short tons.

County and district.	Classification.	Quantity.	Average crude assay of zinc
			Per cent.
Chaffee (ore), Fremont (ore), Gunnison (ore and concentrates), Park (ore), Pitkin (ore), Saguache (ore and concentrates)	Ore and concentrates	3,814	43.49
Mineral	Concentrates	548	33.13
Lake	(Zinc (lead) sulphide ore [a]	104,148	24.00
	(Zinc carbonate ore	142,782	29.20
Eagle and Summit	Ore and concentrates	21,018	43.17
Clear Creek (ore, concentrates, and middlings), and Gilpin (concentrates).	Ore, concentrates, and middlings. [b]	2,736	38.26
San Juan region: Dolores (ore and concentrates), Hinsdale (concentrates), Ouray (concentrates), San Juan (ore and concentrates), San Miguel (concentrates). [c]	Ore and concentrates	10,304	36.04
Total	Ore, concentrates, and middlings.	285,350	28.81
SUMMARY.			
Lake	Crude ore	246,930	26.93
All other countries	Ore, concentrates and middlings.	38,420	40.80
Total	do	285,350	28.81
Total carbonate ore	Ore	144,482	29.20
Total sulphide ore	Ore, concentrates, and middlings.	140,868	28.41

[a] The bulk concentrated at Leadville, Canon City, Pueblo, and Denver; the remainder to zinc smelters and zinc-oxide plants, chiefly in Kansas and Oklahoma. Concentrates produced range from 40 to 50 per cent zinc.

[b] Reconcentrated at Western Chemical Co., Denver.

[c] Reconcentrated and smelted at plant of United States Zinc Co., Pueblo.

As regards the Leadville zinc ore, it will be noted that the average percentage of zinc in the carbonate ore shipped to smelters was 29.2 per cent (as compared with 31.1 in 1911). In 1912, most of the ore averaged above 30 per cent, some lots reaching 40 per cent. Some zinc carbonate was shipped at a profit with a content as low as 22 per cent; some as low as 20 per cent; and occasional lots as low as 17 per cent; an appreciable tonnage was shipped from one mine averaging about 15 per cent. This 15 per cent zinc ore was, however, shipped at a loss, though it was reported of sufficient value to pay for the freight to Oklahoma. The zinc (lead) sulphide ore averaged 24 per cent, which is also practically the percentage in ore milled, representing a range from 28 per cent down to 14 per cent. Ore sold to the Western Chemical Co., in Denver, for concentration ranged from 30 to 14 per cent, with some ore as low as 9 per cent. Sulphide ore to smelters and to zinc oxide plants—24,061 tons—averaged 26.7 per cent zinc.

Some shipments of crude zinc ore from Georgetown, Clear Creek County, averaged from 47 to 53 per cent, and most of the concentrates averaged over 40 per cent, but a considerable tonnage of zinc-lead middlings from Georgetown averaged less than the average of the Leadville concentrating ore. There are some small lots of lead-zinc ore from Georgetown carrying zinc up to 36 per cent, which bring a better price when sold on the lead basis (paying the penalty over 10 per cent zinc), because of the high silver and lead content in the ore. The zinc sulphide concentrates of good tenor of zinc and low in gold and silver content from Eagle and Summit counties are shipped to the smelters in the gas belt of Kansas and Oklahoma. The complex sulphide concentrates of San Juan, San Miguel, and Ouray counties, usually carrying appreciable quantities of gold, silver, copper, and lead, are mostly shipped to the United States Zinc Co., at Pueblo. This plant is capable of handling the concentrates either by further concentration or by smelting direct and is also at some advantage in handling lead and iron concentrates and residues because of the proximity of associated lead smelters, whereas residues from Oklahoma must bear the freight rate of $2.25 to $3.50 per ton back to Pueblo, Denver, or Salida.

The list of Colorado mills, published elsewhere in this report, shows the various processes of separating the zinc, lead, and iron minerals in the complex sulphides. The Empire Zinc Co.'s plant at Canon City treats much of the Leadville sulphide-zinc ore by magnetic separation. The Western Chemical Co.'s plant at Denver also treats much of the Leadville ore, as well as smaller quantities from Clear Creek, Gilpin, Dolores, and Summit counties. At this plant part of the sulphur content is utilized in the manufacture of sulphuric acid, the roasted residue being treated magnetically and by wet concentration. At the Eagle Co.'s mill at Red Cliff the ore is first roasted and the iron is then separated magnetically, the zinc being separated from the lead by wet concentration. At the Wilson (Robinson) mill, Summit County, a somewhat similar process is used. The Wellington mill makes a lead and zinc concentrate by wet concentration, and also a zinc-iron middling. For separating the iron from this last product a roasting and magnetic plant was built in 1911 and operated in 1912. The zinc concentrates from Clear Creek and Gilpin counties are the product from wet milling, as are the concentrates from Mineral County. The product of San Miguel County is all by wet concentration, the magnetic plant at the Tomboy mine not being used. The product from Ouray and San Juan counties is first by wet milling, but in 1912, at the Sunnyside mine, in San Juan County, and at a custom plant at Ouray, the Huff electrostatic machine was installed to separate the iron from the zinc-iron middlings. At the new mill (built 1912–1913) at the Mary Murphy mine, Chaffee County, the Huff electrostatic separator[1] has been installed. At the Pro Patria mill (leased and remodeled by the Rico Wellington Co.), Rico, Dolores County, the process is wet concentration.

The Sutton, Steele & Steele Co. has built a 50-ton custom and demonstrating mill at Denver for the demonstration of the company's

[1] Wentworth, H. A., Electrostatic concentration or separation of ores (the Huff Electrostatic Separator): Trans. Am. Inst. Min. Eng. for 1912, vol. 43, 1913, pp. 411–426, or Bull. Trans. Am. Inst. Min. Eng. No. 66, June, 1912, pp. 633–649.
MacGregor, F. S., Progress in electrostatic ore dressing: Paper presented at the twenty-fourth general meeting of the American Electrochemical Society, at Denver, September 9–11, 1913.

dry tables and dry jigs. This company has also purchased the old mill of the American Zinc Extraction Co., at the mouth of the Yak tunnel, Leadville.

THE VALUE OF ZINC ORE.

The value of zinc ore depends chiefly on its tenor in zinc and on objectionable impurities, especially on iron, manganese, and lime, which increase the corrosion of the retorts, and on lead, arsenic, and antimony, which contaminate the spelter. The value of the ore is also affected by its character, whether it is oxidized or a sulphide or a mixture of both. The sulphide ore must be roasted, but yields a diminished weight for subsequent treatment, which is the most expensive part of the process.[1]

Because of the varying contents of the complex zinc-sulphide ores of Colorado, the value of each lot or car also varies, and no single schedule of payment for zinc ores can be applied to every zinc ore.

The following schedule shows the rates (April, 1911) for the Clear Creek-Gilpin County zinc ores:

Schedule for zinc ores, Clear Creek-Gilpin County.

Base f. o. b. Denver, carloads, $10 per ton.	Unit variation for 1 per cent or 1 ounce change up or down from base.	Market variation for $1 change up or down from base.
$6, spelter, St. Louis		
$4.50, lead, New York		
Zinc, 20 per cent	54 cents per unit	10 cents per unit.
Wet lead, 5 per cent	22 cents per unit	8 cents per unit.
Silver, 15 ounces	40 cents per ounce	
Gold, 0.15 ounce	$10 per ounce	
SiO_2 and CaO, 5 per cent	10 cents penalty for excess	

Sampling charge, 50 cents per ton.
This price to apply to 25 per cent zinc and under; special rates to be given for higher grades.

A comparative statement may be shown in the value of two lots of Leadville carbonate sold when spelter was $7.075: A 20.8 per cent ore netted $5.40 per ton; a 36.85 per cent ore netted $23.67 per ton.

Zinc production [a] in Colorado since the first tonnage of any important quantity was shipped,[b] 1902–1912, in pounds.

Year.	Quantity.	Average price per pound.	Value.
1902	52,582,510	$0.048	$2,523,960
1903	80,616,000	.054	4,353,264
1904	64,976,235	.051	3,313,788
1905	81,198,944	.059	4,790,738
1906	85,488,901	.061	5,214,823
1907	85,018,157	.059	5,016,071
1908	30,130,002	.047	1,416,110
1909	51,210,260	.054	2,765,354
1910	77,089,648	.054	4,162,841
1911	94,607,456	.057	5,392,625
1912	132,222,812	.069	9,123,374
Total and average	835,140,925	.056	48,072,948

[a] Estimated recovery from zinc ores: 1902–1908, estimated by Bureau of Mines, Colorado, from smelting companies; 1908–1912, United States Geological Survey figures as calculated from reports from the mines and smelting companies.
[b] Small quantities were shipped prior to 1902. See History of the zinc industry in Colorado: Min. Science. July 27, 1911, p. 85.

[1] Report of British Columbia Zinc Commission, 1906, Mines Branch, Department of the Interior, Ottawa, Canada; also (abstracted) The valuation of zinc ore and value of argentiferous blende: Min. Reporter, Nov. 22, 1906, pp. 513–516, and Dec. 6, 1906, pp. 567–568.

Source of zinc production in Colorado in 1912, by kinds of ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Zinc ores.	Lead-zinc ores.	Total.
Chaffee	.....	717,512	18,880	736,392
Clear Creek	.....	95,444	1,639,049	1,734,493
Dolores	.....	.....	812,029	812,029
Eagle	.....	7,371	5,651,890	5,659,261
Fremont	.....	447,507	.....	447,507
Gilpin	25,377	.....	.....	25,377
Gunnison	.....	36,468	447,416	483,884
Hinsdale	11,926	.....	.....	11,926
Lake	.....	82,422,971	23,522,812	105,945,783
Mineral	.....	.....	308,681	308,681
Ouray	95,405	.....	45,262	140,667
Park	.....	99,519	32,756	132,275
Pitkin	.....	396,234	88,273	484,507
Saguache	.....	24,400	510,528	534,928
San Juan	1,478,384	.....	1,000,210	2,478,594
San Miguel	2,943,783	.....	.....	2,943,783
Summit	.....	742,226	8,600,499	9,342,725
Total, 1912	4,554,875	84,989,652	42,678,285	132,222,812
Total, 1911	4,994,219	51,388,865	38,224,372	94,607,456
Increase (+) or decrease (−)	−439,344	+33,600,787	+4,453,913	+37,615,356

ORE TONNAGES AND METAL CONTENT.

Subdivision of crude ore sold or treated in Colorado in 1912, by counties, in short tons.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	9,150	6	682	.....	.....	.....	9,838
Chaffee	314	453	7,925	1,352	193	50	10,287
Clear Creek	67,391	22	2,487	116	1,712	31,166	102,894
Custer	4,310	8	12	.....	.....	.....	4,330
Dolores	1,684	4,366	755	.....	.....	1,680	8,485
Eagle	2,051	170	3,572	16	.....	28,355	34,164
Fremont	.....	.....	.....	709	306	.....	1,015
Gilpin	115,556	2,521	503	.....	72	.....	118,652
Gunnison	13,036	.....	22	54	45	889	14,046
Hinsdale	731	45	8,705	.....	73	.....	9,554
Lake	210,938	5,722	43,947	173,374	54	73,556	507,591
La Plata	2,747	.....	14	.....	.....	.....	2,761
Mesa	.....	22	.....	.....	.....	.....	22
Mineral	29,968	.....	.....	.....	.....	36,520	66,488
Moffat	.....	64	.....	.....	.....	.....	64
Ouray	81,881	133	6,502	.....	194	1,265	89,975
Park	1,499	.....	979	139	13	56	2,686
Pitkin	22,271	.....	68,600	783	.....	137	91,791
Rio Grande	.....	133	.....	.....	.....	.....	133
Saguache	626	8	130	42	9	8,644	9,459
San Juan	98,242	43	31,468	.....	4,139	7,025	140,917
San Miguel	451,104	.....	4,592	.....	.....	.....	455,696
Summit	3,629	2	1,850	1,361	.....	39,764	46,606
Teller	849,172	.....	.....	.....	.....	.....	849,172
Total, 1912	[a] 1,966,300	13,718	182,745	177,946	6,810	229,107	2,576,626
Total, 1911	1,874,103	18,221	158,984	110,845	1,398	214,385	2,377,936
Increase (+) or decrease (−)	+92,197	−4,503	+23,761	+67,101	+5,412	+14,722	+198,690
Average recovered value in gold and silver per ton	$10.53	$23.26	$7.18	$0.51	$41.05	$2.17	$9.61

[a] Includes 158,429 tons of silver ore and 1,807,871 tons of gold and silver ore. Oxidized ores include 67,957 tons of silver ore and 23,193 tons of gold and silver ore. Sulphide ores include 90,472 tons of silver ore and 1,784,678 tons of gold and silver ore. Oxidized silver ores include 62,652 tons of iron-manganese ore and 5,305 tons of siliceous ore.

The ores of San Miguel and Teller counties, although mostly sulphide, contain much mixed oxide and sulphide ores, classed here as sulphide.

Content of dry and siliceous ores sold or treated in Colorado in 1912, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	9,150	5,533.02	55,413	14,893	21,919	.....
Chaffee	314	138.48	6,892	5,006	8,630	.....
Clear Creek	67,391	18,427.97	171,913	304,714	573,784	.....
Custer	4,310	816.97	24,052	220	8,178	.....
Dolores	1,684	320.68	28,819	448	8,045	.....
Eagle	2,051	1,872.87	39,907	28,386	1,598	.....
Gilpin	115,556	37,332.23	270,419	736,061	1,131,520	25,377
Gunnison	13.036	5,997.26	17,704	1,934	165,586	.....
Hinsdale	731	116.28	10,778	2,143	7,199	11,926
Lake	210,938	42,473.10	1,938,285	1,421,561	3,802,920	.....
La Plata	2,747	6,546.90	47,105	811	4,555	.....
Mineral	29,968	837.82	677,569	13,039	1,374,856	.....
Ouray	81,881	50,189.45	441,693	350,381	2,166,481	95,405
Park	1,499	371.51	19,849	645	4,437	.....
Pitkin	22,271	7.35	229,401	934	161,996	.....
Saguache	626	77.17	7,784	18,827	26,815	.....
San Juan	98,242	21,424.60	244,799	476,516	4,191,700	1,478,384
San Miguel	451,104	115,971.10	1,064,302	819,086	6,440,756	2,943,783
Summit	3,629	311.58	34,638	491	61,551	.....
Teller	849,172	532,529.51	66,117	.....	.....	.....
Total	1,966,300	841,295.84	5,397,439	4,196,096	20,162,526	4,554,875

Content of copper ores sold or treated in Colorado in 1912, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*
Boulder	6	2.99	9	616	53
Chaffee	453	2.80	1,292	59,958	15,415
Clear Creek	22	35.62	272	1,850	.....
Custer	8	0.21	475	1,251	269
Dolores	4,366	34.34	31,870	688,707	866
Eagle	170	173.63	3,608	25,030	94
Gilpin	2,521	6,075.05	35,388	282,773	18,363
Hinsdale	45	4.76	1,522	9,503	1,805
Lake	5,722	2,136.03	144,227	471,437	62,486
Mesa	22	0.43	257	5,685	20
Moffat	64	.....	124	25,085	.....
Ouray	133	5.57	2,178	14,849	1,061
Rio Grande	133	268.47	896	29,673	313
Saguache	8	15.23	12	471	.....
San Juan	43	1.40	2,120	5,445	1,576
Summit	2	3.33	77	272	.....
Total	13,718	8,759.86	224,327	1,622,605	102,321

Content of lead ores sold or treated in Colorado in 1912, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*
Boulder	682	241.22	16,913	6,667	283,850
Chaffee	7,925	4,343.07	92,185	51,779	851,691
Clear Creek	2,487	1,375.73	92,086	25,807	1,076,907
Custer	12	0.26	899	535	1,997
Dolores	755	7.36	20,488	368	560,772
Eagle	3,572	254.43	110,619	93,632	681,941
Gilpin	503	313.00	9,231	2,061	192,468
Gunnison	22	28.95	328	84	3,531
Hinsdale	8,705	204.72	21,339	34,637	1,219,490
Lake	43,947	6,593.46	452,206	36,913	10,208,645
La Plata	14	2.64	843	107	2,201
Ouray	6,502	359.83	87,932	10,546	750,333
Park	979	1,976.31	9,717	7,966	146,979
Pitkin	68,600	0.63	298,224	22,018	8,215,165
Saguache	130	23.86	1,983	2,109	47,849
San Juan	31,468	3,020.57	117,420	206,297	3,588,519
San Miguel	4,592	91.84	89,407	26,411	988,866
Summit	1,850	928.93	49,110	11,279	819,429
Total	182,745	19,766.81	1,470,930	539,216	29,640,633

Content of zinc ores sold or treated in Colorado in 1912, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	1,352	.....	36	785	1,096	717,512
Clear Creek	116	.....	.....	.....	.....	95,444
Eagle	16	.....	.....	.....	.....	7,371
Fremont	709	.....	1,644	21,418	31,419	447,507
Gunnison	54	.....	.....	.....	.....	36,468
Lake	173,374	513.48	128,290	44,710	1,201,622	82,422,971
Park	139	4.66	70	99	882	99,519
Pitkin	783	.....	.....	.....	.....	396,234
Saguache	42	.....	.....	.....	.....	24,400
Summit	1,361	14.37	352	.....	.....	742,226
Total	177,946	532.51	130,392	67,012	1,235,019	84,989,652

Content of copper-lead ores sold or treated in Colorado in 1912, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*
Chaffee	193	1.68	3,565	15,978	105,701
Clear Creek	1,712	1,136.25	28,662	94,685	548,784
Fremont	306	12.24	1,795	14,485	24,537
Gilpin	72	35.15	1,167	4,875	9,249
Gunnison	45	3.33	1,964	4,920	5,625
Hinsdale	73	3.72	1,083	7,456	29,306
Lake	54	16.81	2,285	4,650	6,757
Ouray	194	165.10	9,638	20,281	27,363
Park	13	0.20	1,159	1,370	2,985
Saguache	9	1.62	142	988	9,277
San Juan	4,139	560.49	337,989	361,539	490,898
Total	6,810	1,936.59	389,449	531,227	1,260,482

Content of lead-zinc ores sold or treated in Colorado in 1912, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	50	6.56	677	64	10,045	18,880
Clear Creek	31,166	573.70	81,007	22,345	1,324,258	1,639,049
Dolores	1,680	3.14	19,111	392	642,717	812,029
Eagle	28,355	82.70	9,601	128	556,523	5,651,890
Gunnison	889	1.67	9,012	1,159	132,125	447,416
Lake	73,556	1,635.87	335,104	86,529	10,951,814	23,522,812
Mineral	36,520	3,322.53	37,340	10,846	4,355,366	308,681
Ouray	1,265	53.97	3,736	4,495	43,806	45,262
Park	56	5.97	250	241	12,473	32,756
Pitkin	137	.....	879	.....	28,172	88,273
Saguache	8,644	66.19	9,388	7,084	420,904	510,528
San Juan	7,025	320.83	12,646	13,494	841,641	1,000,210
Summit	39,764	351.51	75,676	4,370	3,521,442	8,600,499
Total	229,107	6,424.64	594,427	151,147	22,841,286	42,678,285

MINING INDUSTRY OF COLORADO IN 1912.

The gross value of Colorado's output of gold, silver, copper, lead, and zinc recovered from placers, from gold-silver bullion, and from ore sold or treated in 1912, was $37,320,966, as compared with $32,418,218 in 1911, an increase in value for 1912 of $4,902,748, or 15 per cent.

Gold in Colorado in 1912 showed a decrease in value of production of $413,413; silver, an increase of 881,902 ounces; copper, a decrease of 917,185 pounds; lead, an increase of 5,562,978 pounds; and zinc (figured as spelter and zinc in zinc oxide) an increase of

37,615,356 pounds. With increased market prices for silver, copper, and zinc, there were increases in value of $169,644 for copper, of $1,165,434 for silver, of $250,334 for lead, and of $3,730,749 for zinc.

The smelting situation in 1912 in Colorado remained as it was at the close of 1911. The Globe, the Leadville, and the Pueblo plants were operated continuously, but, as has been the case for several years, not at full capacity. The Durango smelter, temporarily closed in November, 1911, was reopened in the spring of 1912. The Salida smelter was actively operated. An increased tonnage of complex zinc ores from Colorado and other Western States was treated at the United States Zinc Co.'s plant at Pueblo. The semipyritic plant at Golden, closed in November, 1911, was not reopened.

The following list gives the active smelting plants in Colorado in 1912:

List of active smelting plants in Colorado in 1912.

City.	Plant.	Owner.
Denver	Globe	American Smelting & Refining Co.
Pueblo	Pueblo	Do.
Pueblo [a]	United States Zinc Co	Do.
Leadville	Arkansas Valley	Do.
Durango	Durango	Do.
Salida		Ohio & Colorado Smelting & Refining Co.

[a] Zinc-lead-copper-gold-silver ores.

The output of Cripple Creek in 1912 showed an increase of $445,709 in gold, the production being $11,008,362, or 59 per cent of the total gold yield of the State. The drainage of the mines by the Roosevelt drainage tunnel permitted the sinking of shafts several hundred feet, with the exception of the Vindicator and Golden Cycle mines, where electric pumps were installed. A greatly increased tonnage of low-grade dump and mine ores was treated in the district, at the Stratton's Independence, Portland, and other cyanide mills. Shipments of the higher-grade ores to smelters showed a small increase in tonnage and also an increase in average content of gold, but the tonnage to the custom plants at Colorado Springs showed a small decrease. The chlorination plant of the Portland plant was gradually transformed to a cyanide plant in 1911, and with the closing of the United States Reduction & Refining Co.'s chlorination plant at the end of 1911, the use of chlorination in the mills of Colorado was supplanted by cyanidation.

Lake County (chiefly Leadville) produced an increased tonnage, with small decreases in the quantity of gold and silver, an appreciable decrease for copper, but an increase of 7,735,155 pounds of lead and of 34,335,327 pounds of zinc, with a consequent increase in value for the county of $3,636,379, which placed Lake County first in rank in value of output. The tonnage of zinc carbonate produced, chiefly from Carbonate Hill, but also from Fryer, Breece, Iron, Printer Boy, and Rock Hills, increased from 83,905 tons of 31.1 per cent zinc in 1911 to 142,782 tons of 29.2 per cent zinc in 1912; and the zinc sulphide increased from 79,376 tons in 1911 to 104,148 tons in 1912. The tonnage of iron sulphide decreased

somewhat; the tonnage of lead and iron-manganese oxide ores increased; but the tonnage of siliceous oxide ores decreased.

The San Juan region—Dolores, La Plata, Ouray, San Juan, and San Miguel counties combined—showed increased yields of all the metals, other than gold, for which there was a decrease in value of $916,419, the yield from Ouray County alone showing a decrease of $903,368. There was also a decrease of $151,546 in gold from La Plata County, but an increase of $187,111 from San Juan County. A greatly reduced tonnage was mined and milled from the Camp Bird mine, in the Sneffels district, Ouray County. San Juan County's output showed increases for all the metals. San Miguel County's output showed a small increase in value. La Plata County's gold and silver yield decreased. Dolores County showed a large increase for 1912, with important increases for all the metals, except gold. Hinsdale County, also part of the San Juan group of counties, showed a large increase in value, there being increases for all the metals. Mineral County (Creede), also part of the San Juan region, has been considered alone. Gold, lead, and zinc yields decreased considerably, while silver increased appreciably.

Boulder County showed a heavy decrease of gold, but increases of silver and lead. Clear Creek County showed a decreased yield of gold, silver, and copper, but increases of lead and zinc. The lower Clear Creek mines showed a small decrease of all the metals and Upper Clear Creek mines showed increases in quantity of gold, lead, and zinc, but decreases of silver and copper, with an increase in total value. Gilpin County showed an increase for all the metals, with an increase both in bullion and in material smelted.

The Pitkin County (Aspen) yield of lead decreased, but the output of silver increased, and a considerable yield of zinc was made. The Summit County gold output from dredge operations increased considerably, and the yield of zinc also increased largely. This county ranks second in zinc yield. In Eagle County, there were material increases for all the metals, particularly for zinc. With the exception of a small increase in gold yield, the output of metals in Park County again decreased. The yield from Gunnison County showed small decreases for all the metals. The total value of the yield from Chaffee County increased 50 per cent. Saguache County became an important county in the yield of lead and zinc in 1912, with increases for the other metals as well.

The following table shows the production of gold, silver, copper, lead, and zinc in Colorado, by counties:

Mine production of gold, silver, copper, lead, and zinc in 1912 in Colorado, by counties.

County.	Producing mines.	Tonnage of deep mines.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Boulder	126	9,838	5,777.23	$119,426	72,335	$44,486
Chaffee	19	10,287	4,716.03	97,489	104,686	64,382
Clear Creek	91	102,894	21,565.28	445,794	373,940	229,973
Costilla	2	.....	22.74	470	3	2
Custer	8	4,330	817.44	16,898	25,426	15,637
Dolores	7	8,485	365.52	7,556	100,288	61,677

[a] Includes placer production.

Mine production of gold, silver, copper, lead, and zinc in 1912 in Colorado, by counties—Continued.

County.	Producing mines.	Tonnage of deep mines.	Gold.		Silver.	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Douglas	1	.....	3.64	$75	.....	.....
Eagle	19	34,164	2,384.59	49,294	163,735	$100,697
Fremont	1	1,015	12.24	253	3,439	2,115
Gilpin	151	118,652	43,755.43	904,505	316,205	194,466
Gunnison	14	14,046	6,062.69	125,327	29,035	17,857
Hinsdale	12	9,554	329.48	6,811	34,722	21,354
Lake	100	507,591	53,368.75	1,103,230	3,000,397	1,845,244
La Plata	23	2,761	6,549.54	135,391	47,948	29,488
Mesa	1	22	.43	9	257	158
Mineral	10	66,488	4,160.35	86,002	714,909	439,669
Moffat	4	64	214.39	4,432	134	82
Montrose	2	.....	33.23	687	10	6
Ouray	35	89,975	50,773.92	1,049,590	545,177	335,284
Park	27	2,686	3,288.58	67,981	31,234	19,209
Pitkin	9	91,791	7.98	165	528,504	325,030
Rio Grande	1	133	268.47	5,549	896	551
Routt	1	.....	30.86	638	16	10
Saguache	12	9,459	184.07	3,805	19,309	11,875
San Juan	41	140,917	25,327.89	523,574	714,974	439,709
San Miguel	26	455,696	116,062.94	2,399,234	1,153,709	709,531
Summit	39	46,606	20,608.47	426,015	164,665	101,269
Teller	74	849,172	532,529.51	11,008,362	66,117	40,662
Total, 1912	856	2,576,626	899,221.69	18,588,562	8,212,070	5,050,423
Total, 1911	861	2,377,936	919,220.54	19,001,975	7,330,168	3,884,989
Increase (+) or decrease (−)	−5	+198,690	−19,998.85	−413,413	+881,902	+1,165,434

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Boulder	22,176	$3,659	305,822	$13,762	.....	.....	$181,333
Chaffee	133,570	22,039	992,578	44,666	736,392	$50,811	279,387
Clear Creek	449,401	74,151	3,523,733	158,568	1,734,493	119,680	1,028,166
Costilla	.....	.....	.....	.....	.....	.....	472
Custer	2,006	331	10,444	470	.....	.....	33,336
Dolores	689,915	113,837	1,212,400	54,558	812,029	56,030	293,658
Douglas	.....	.....	.....	.....	.....	.....	75
Eagle	147,176	24,284	1,240,156	55,807	5,659,261	390,489	620,571
Fremont	35,903	5,924	55,956	2,518	447,507	30,878	41,688
Gilpin	1,025,770	169,252	1,351,600	60,822	25,377	1,751	1,330,796
Gunnison	8,097	1,336	306,867	13,809	483,884	33,388	191,717
Hinsdale	53,739	8,867	1,257,800	56,601	11,926	823	94,456
Lake	2,065,800	340,857	26,234,244	1,180,541	105,945,783	7,310,259	11,780,131
La Plata	918	151	6,756	304	.....	.....	165,334
Mesa	5,685	938	20	1	.....	.....	1,106
Mineral	23,885	3,941	5,730,222	257,860	308,681	21,299	808,771
Moffat	25,085	4,139	.....	.....	.....	.....	8,653
Montrose	.....	.....	.....	.....	.....	.....	693
Ouray	400,552	66,091	2,989,044	134,507	140,667	9,706	1,595,178
Park	10,321	1,703	167,756	7,549	132,275	9,127	105,569
Pitkin	22,952	3,787	8,405,333	378,240	484,507	33,431	740,653
Rio Grande	29,673	4,896	313	14	.....	.....	11,010
Routt	.....	.....	.....	.....	.....	.....	648
Saguache	29,479	4,864	504,845	22,718	534,928	36,910	80,172
San Juan	1,063,291	175,443	9,114,334	410,145	2,478,594	171,023	1,719,894
San Miguel	845,497	139,507	7,429,622	334,333	2,943,783	203,121	3,785,726
Summit	16,412	2,708	4,402,422	198,109	9,342,725	644,648	1,372,749
Teller	.....	.....	.....	.....	.....	.....	11,049,024
Total, 1912	7,107,303	1,172,705	75,242,267	3,385,902	132,222,812	9,123,374	37,320,966
Total, 1911	8,024,488	1,003,061	69,679,289	3,135,568	94,607,456	5,392,625	32,418,218
Increase (+) or decrease (−)	−917,185	+169,644	+5,562,978	+250,334	+37,615,356	+3,730,749	+4,902,748

Tonnage of ore sold or treated, number of deep mines producing, and average value per ton of ore from deep mines in Colorado in 1911 and 1912, by counties.

County.	Ore sold or treated.			Number of deep mines producing.		Average value per ton.	
	1911	1912	Increase (+) or decrease (−).	1911	1912	1911	1912
	Short tons.	*Short tons.*	*Short tons.*				
Boulder	15,816	9,838	− 5,978	115	126	$12.75	$18.43
Chaffee	7,459	10,287	+ 2,828	17	16	23.60	26.71
Clear Creek	105,774	102,894	− 2,880	91	88	10.03	9.99
Custer	3,670	4,330	+ 660	8	8	3.69	7.70
Dolores	3,276	8,485	+ 5,209	12	7	30.30	34.60
Eagle	33,177	34,164	+ 987	10	18	13.26	18.16
Fremont	382	1,015	+ 633	1	1	30.22	41.07
Gilpin	103,038	118,652	+ 15,614	158	151	10.77	11.22
Gunnison	11,926	14,046	+ 2,120	16	12	18.65	13.60
Hinsdale	723	9,554	+ 8,831	6	12	24.98	9.89
Lake	438,419	507,591	+ 69,172	94	100	18.58	23.21
La Plata	10,058	2,761	− 7,297	19	23	33.11	59.88
Mesa	.....	22	+ 22	.....	1	.....	50.27
Mineral	65,932	66,488	+ 556	9	10	13.49	12.16
Moffat	.....	64	+ 64	.....	1	.....	65.84
Montezuma	1	.....	− 1	2	.....	42.00	.....
Ouray	133,252	89,975	− 43,277	31	35	18.56	17.73
Park	5,780	2,686	− 3,094	22	20	24.02	32.10
Pitkin	88,823	91,791	+ 2,968	11	9	8.32	8.07
Rio Grande	.....	133	+ 133	.....	1	.....	82.78
Saguache	184	9,459	+ 9,275	8	12	52.56	8.48
San Juan	108,088	140,917	+ 32,829	37	41	9.31	12.21
San Miguel	429,354	455,696	+ 26,342	28	26	8.35	8.31
Summit	55,904	46,606	− 9,298	35	31	14.91	20.96
Teller	756,900	849,172	+ 92,272	92	74	14.00	13.01
Total	2,377,936	2,576,626	+198,690	822	823	.....	.....
Average value per ton	.....	.....	.....	.....	.....	13.08	14.32

REDUCTION MILLS IN COLORADO.

The following list gives the reduction mills in Colorado in 1912:

List of reduction mills in Colorado in 1912, by counties.

[A=active. B=building, 1912. C=completed, 1912. E=experimental, 1912. I=idle.]

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
BOULDER COUNTY.				*Short tons.*
Eureka Mining & Milling Co. (A).	Boulder City..	Tungsten concentration.	.....	.....
Watts (A)	.....do.....	Chlorination.....	Laboratory plant.....	.....
Wano (I).....	Central.....	Roasting and cyanide.	Rolls, Merton roaster, cyanide tanks.	45
Prince Arthur (I).....	.....do.....	Cyanide.....	Old 10-stamp mill being remodeled in 1913 to cyanidation, with Dorr classifier, tanks, etc.	40
Weaver Bros. (A) (Black Swan).	Gold Hill.....	Amalgamation, concentration.	Crusher, rolls, 10 stamps, Wilfley tables, Frue vanners.	40
Black Cloud (I) (Pollock).	.....do.....	.....do.....	1 Dodge crusher, 20 stamps, 3 cone classifiers, 4 Callow cones, 3 Wilfley, 2 Card, and 1 Cammett tables, 1 Wilfley slimer, 2 canvas slimers.	60
Gold Bullion (A) (Prussian).	.....do.....	Concentration.....	Crusher, 2 sets of rolls, sizers, screens, 9 Monell tables, 6 Monell slimers.	75

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
BOULDER COUNTY—con.				*Short tons.*
Gold Hill Cons. (I)	Gold Hill	Roasting, concentration, cyanidation.	1 Hathaway crusher, 1 Horn concentrating table, Beam converter process, 1 agitation and 1 percolation tank, 1 filter.	25–50
Inter-Ocean (I)	do	Concentration, cyanidation.	1 crusher, 2 rolls, 2 Frue vanners, 2 Wilfley tables, 4 percolation tanks.	50
Nugget (A)	do	Amalgamation, concentration.	15 stamps, concentrating tables	25
Slide (I)	do	Roasting and cyanidation.	15 stamps	50
Walter Bros. (A)	do	Amalgamation, concentration.	Regrinder, amalgamating plates, roaster, concentrating table.	4
Alton (E)	Grand Island (Cardinal).	Amalgamation, concentration. Also tungsten concentration.[a]	1 Samson crusher, 15 stamps, 1 Rogers mill, 1 Denver quartz mill, 1 Callow tank classifier, 1 own make hydraulic classifier, 1 Wilfley, 1 card table, 4 canvas tables, 1 Hartz jig, 1 Monell slimer. Expect to add cyanide in 1913.	25
Cardinal (I) (Primos Chemical Co.) formerly called Boulder County.	do	Concentration (tungsten tailings).[a]	Remodeled gold stamp-mill, 1 Blake crusher, 10 stamps, 20-mesh screen, 2 Wilfley tables. Tailings to Callow cones to Krupp tube mill to 3 Frue vanners, tailings to 3,600 square feet of canvas on stationary tables.	[c]20
Clarasdorf (I)	Grand Island (Nederland on lower middle Boulder Creek.)	do[a]		5
Colorado Tungsten Mines Co. (A).	Grand Island (Carrie Nation Park).	Concentration		
Lakewood (A)	Grand Island (Cardinal).	Concentration (tungsten ore).[a b]	Separate crushing and sampling apparatus for custom work. Mine ore: Blake crusher, 10 stamps (1,000-pound), 2 Wilfley tables, 11 Frue vanners, Prosser tube mill, Dorr classifier, 10,320 square feet canvas plant.	40
Smith & Ardourell (A).	Grand Island (Nederland on Beaver Creek).	Concentration (tungsten tailings).[a]	Shaking screen, classifier, to Wilfley table, to Monell slime concentrators. Wilfley middling reground in Denver quartz mill. Tailings over 4 canvas tables.	20
Tungsten M. & M. Co. (A).	Grand Island (Nederland).	Concentration (tungsten ore).[a]	Jaw crusher, Denver quartz mill, 20-mesh screen, oversize to Monell concentrator, undersize to classifier, coarse to Monell table, fine to Monell slimer.	5
Wolf Tongue (A)	do	Concentration (tungsten ore).[d e]	Samson crusher, Blake crusher, McFarlane rolls, Vezen sampler, trommel, jigs, 10 (750-pound) stamps for regrinding, 5 Card tables, 1 Wilfley table, 3 Monell slimers, 16 canvas tables.	25
Colorado Metal & Chemical Co. (E) (Bailey mill).	Grand Island (Eldora).	Cyanidation	Crusher, 2 rolls, tube mill, Portland filter press, 3 revolving barrels. Agitation process.	30

[a] Parmelee, H. C., The problems of tungsten concentration: Metall. and Chem. Eng., July, 1911, pp. 341–342, and August, 1911, pp. 409–411.
[b] Palmer, Leroy A., Tungsten in Boulder County, Colo.: Eng. and Min. Jour., July 19, 1913, pp. 99–105.
[c] Of tailings.
[d] Parmelee, H. C., op. cit.
[e] Palmer, Leroy A., op. cit.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
BOULDER COUNTY—con.				*Short tons.*
Caribou (I)	Grand Island (Caribou).	Concentration	1 crusher, 10 stamps, classifier, 1 Wilfley table, 1 canvas table.	40
Cash (A)	Magnolia	Roasting, cyanidation, and concentration.		20
Cashier (I)	Sugar Loaf	Concentration	Crusher, rolls, Richards jigs, 5 card tables.	75
Gladys (I)	do	Amalgamation	5 stamps, plate, 1 Wilfley table	25
Good Luck (A)	do	Roasting, blanket amalgamation, and cyanidation.	1 Blake crusher, 2 sets Gates rolls, Davis rolls, 75-ton rotary roaster, regrinding in Chilean mill. 7 percolation tanks, zinc precipitation.	75
Logan (A)	do	Amalgamation	Laboratory plant	
Little Maxine (A)	do	do	5 stamps, 1 arrastre. (Prospect outfit.)	5
U. S. Gold Corporation (I).	do	Cyanidation	Dry crushing. 1 crusher, 3 sets rolls, 8 percolation tanks. Electrolytic precipitation, Davis patent. Roasters to be installed.	150
Ruby (I) (Milwaukee, Arcade).	Ward	Amalgamation, concentration.	10 stamps, 2 classifiers, 2 Frue vanners, 2 Card tables.	30
Big Five (I) (Dew Drop).	do	Concentration	2 crushers, 1 roller mill, 3 Wilfley tables.	50
Golden Slipper (I)	do	Cyanidation	10 stamps, 2 arrastres, cyanide tanks.	50
Morning and Evening Star (I).	do	Amalgamation, concentration.	10 stamps	50
Utica Hill (I)	do	Cyanidation, without roasting.	1 Blake crusher, 10 stamps, 3 storage, 3 agitation, 1 gold solution, and 1 sump tank. Sand filter.	30–35
Ward Success (I)	do	Concentration		25
Conqueror (I)	do	Amalgamation, concentration.	2 crushers, 20 stamps, 1 Hardinge tube mill, 2 Traylor vanners, blanket concentration.	70
Struggler (I)	do	Concentration	10 stamps, copper plates, 5-ft. Huntington mill.	30
CHAFFEE COUNTY.				
Condor (I)	Monarch	Concentration	2 rolls, 1 Spitzkasten, 2 Wilfley tables.	25–30
Mary Murphy (C)	Chalk Creek	Concentration, with subsidiary amalgamation and electrostatic separation.	1 Farrel, 1 Blake crusher, 2 sets rolls, 1 Gates tube mill, 1 Hardinge pebble mill, 1 Richards pulsating classifier, two 2-compartment Hartz jigs, 10 Card tables, 4 Deister slimers, 3 Monell slimers, 4 Huff electrostatic separators.	125
Sedalia (I)	Turret	Concentration	Idle since 1907	40
CLEAR CREEK COUNTY.				
Alice (A)	Alice	Amalgamation, concentration.	Crusher, 5 stamps, 1 Card table	20
Lombard (I)	do	do	1 Blake crusher, 20 stamps, 1 classifier, 3 Wilfley and 3 Card tables.	100
Little Lalla (A)	do	Amalgamation	5 stamps and plate	25
Santiago (I)	Argentine	Concentration	Crushers, rolls, concentrating tables.	40
Stevens (I)	do	do	1 crusher, 1 set rolls, 5 concentrating tables, jigs, trommels.	50
Waldorf (I)	do	do	1 crusher, 1 set rolls, 2 Allis-Chalmers vanners, 5 concentrating tables. Contemplate remodeling.	50
Conqueror (I)	Empire	do	Crusher, 2 sets rolls, jigs, 1 Wilfley table, 3 Frue vanners.	40

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
CLEAR CREEK COUNTY—continued.				*Short tons.*
Crown Prince (A) (new system).	Empire	Concentration, amalgamation.	1 Blake crusher, 10 stamps, 1 homemade classifier, 2 Wilfley tables, 2 Gilpin County bumpers.	30
Pioneer (B)	do	do	10 stamps, tables	30
Silver Mountain (I)	do	Amalgamation	5-foot Huntington mill	20
Boston (I) (Kelly)	Griffith	Concentration	1 crusher, 2 rolls, 4 Hartz jigs, 1 vanner.	75
Capital (A)	do	Amalgamation, concentration.	1 Samson, 1 Blake crusher, Akron Chilean mill, 8 Swain classifiers, 1 Allis-Chalmers vanner, 5 Swain and 12 Card tables.	200
Dives-Pelican (A) (Burleigh).	do	Concentration	Crusher, rolls, jigs, tables, vanners.	200
Mendota (A)	do	do	1 Blake crusher, 2 McFarlane rolls, trommel screens, 1 Card table, Hartz jigs.	30–60
Mineral Chief (A)	do	do	1 crusher, 2 concentrating tables, jigs.	50
Nashotah (A)	do	do	1 Blake crusher, 1 Samson crusher, two 6-foot Akron Chilean mills, 15 Card tables, settling tanks, 2 homemade classifiers.	225
Scotia (A)	do	do	Crusher, rolls, jigs, tables	50
Malm (I) [a]	do	Dry chlorination	Uncompleted	50
Terrible (I)	do	Concentration	Jigs and tables	150
Argo (C) [b, c]	Idaho	Amalgamation, concentration, cyanidation.	20 stamps (1,050-pound) amalgamating plates electrified amalgam traps, 9 Card tables, 6 Dorr classifiers, 7 Dorr thickeners, Parral and Dorr agitators. Filter tanks, zinc precipitating boxes.	100
Black Eagle (A)	do	Amalgamation, concentration.	1 crusher, 5 stamps (1,050-pound) settling tanks, 1 Monell, 1 Wilfley table.	20–25
Combination (A) (Staley).	do	do	15 stamps, plates, tube mill, 4 Wilfley and 2 Card tables, 1 Deister slimer.	50
Colorado-McKelvey (E)	do	Amalgamation, concentration.	Universal crusher, 2 screens, McFarlane rolls, Eureka crusher, Abbè tube mill, 3-compartment Joplin jig.	25
Dorit (B)	do	do	Crusher; Lane mill, amalgamating plates, classifier, Wilfley tables, Eccleston sand tables, and Eccleston slimer. Built in 1913.	50
Gem (A) (Newton).	do	Concentration	East end: 7 by 10 crusher, 14 by 26 rolls, one 4-compartment jig, two 3-compartment jigs. 5 No. 5 Wilfley tables, 1 multiple deck Wilfley slimer.	150
			West end: 7 by 10 crusher, 14 by 26 rolls, three 36-inch trommels, three 3-compartment jigs, 6 No. 5 Wilfley tables, three 3-compartment jigs. Center abandoned.	.....
Gem (A) (Newton annex).	do	do	East end: (Not used) 10 stamps, automatic feed. Plates. 3 No 5 Wilfleys. 1 Wilfley slimer.	200
			West end: 10 by 16 Blake crusher, 14 by 24 rolls. 14 by 30 rolls. Three 48-inch trommels. Four 3-compartment jigs. Two 2-compartment jigs. 6 No. 5 Wilfley tables. 1 Wilfley slimer.	.....

[a] See Mines and Minerals, January, 1910, pp. 370–374.
[b] See Goodale, Stephen L., The Argo cyanide mill, Idaho Springs, Colo.: Eng. and Min. Jour., Aug. 30, 1913, pp. 385–389.
[c] See Twelfth Biennial Rept. State Bureau of Mines, 1911–12, 1913, p. 80.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
CLEAR CREEK COUNTY—continued.				*Short tons.*
Gem (A) (Newton annex).	Idaho	Concentration	Center: 20 stamps, automatic feet, 5 No. 5 Wilfley tables, 2 Wilfley slimers.	
Hoosac (B) [a]	do	Amalgamation, concentration.	10 stamps (1,050-pound) (90 drops per minute), plates, classifiers, 3 Wilfley tables.	35
Hudson (A) [b]	do	Amalgamation, concentration, cyanidation.	20 stamps, plates, 3 Dorr thickeners, Akins classifier, Callow cone.	88
Idaho Springs Reduction. (I).	do	Amalgamation, concentration.	Richards classifier, Wilfley, Card, and Deister tables. Partly dismantled.	20
Jackson (A)	do	Concentration	1 crusher, 2 Huntington mills, trommel screens, 4 Card tables, Roberts buddles and belt tables.	50
Lincoln (I)	do	Amalgamation, concentration.	10 stamps	50
Little Mattie (A)	do	do	40 stamps (twenty 1,060-pound, twenty 900-pound), 7 Wilfley tables. Contemplate adding 3 more Wilfleys and 1 tube mill.	100
Mixsell (I)	do	Concentration	Stamps, tables	30
Standard (I)	do	Amalgamation, concentration.	1 crusher, 20 stamps, 1 roller mill, 4 Wilfley tables.	30–40
Stanley (I)	do	do	1 crusher, rolls, jigs, stamps, plates, table.	50
Waltham (I)	do	do	10 slow drop stamps remaining. Partly dismantled.	30
Wilkie (I)	do	Concentration	Crusher, stamps, jigs, Wilfley tables. Partly dismantled.	40
Chicago Mountain (I)	Cascade	Amalgamation	1 stamp, plate	4
Humboldt (I)	do	Amalgamation, concentration.	10 stamps, Wilfley tables	40
Katie Emmet (I)	do	Amalgamation	5 stamps (prospect outfit)	20
Blue Ridge (B)	Montana	Concentration	2 sets rolls, 3 Card tables, completed 1913.	50
Jo Reynolds (I)	do	do		40
Syndicate (I)	do	Amalgamation, concentration.	30 stamps, tables	100
Two American Sisters (I).	do	Concentration	1 crusher, 10 stamps, Davis roller mill, screen, 3 Wilfley and 1 Card tables.	30
Lamartine (I) (Lang and Roberts).	Trail	do	1 crusher, trommel, Cammett table, 3 Hartz jigs.	50
New Era (A)	do	Amalgamation, concentration.	1 crusher, 10 stamps, plates, 1 set rolls, jigs (old), 2 Wilfley tables.	30
Oneida (B)	do	Cyanide-concentration.	Crusher, 10 stamps (1,050-pound), Flood classifiers, 4 Card tables, regrinder, 1 Dorr classifier, 1 Dorr thickener, 3 continuous decantation tanks, 3 agitating tanks.	50
CUSTER COUNTY.				
Bassick (A)	Querida	Cyanidation	Six 50-ton tanks (3 not in use), Dorr classifier, Butters filter press (not used).	35
Marion (I) [c]	Fairview	Concentration	Samson crusher, McFarlane rolls, trommels, tube mill, Callow cones, Richards classifier, 19 Card tables, 1 Bunker Hill screen.	100
DENVER COUNTY.				
Sutton, Steele & Steele.	Denver	Dry concentration	Demonstration plant for SSS. tables, jigs, etc.	50

[a] See Eng. and Min. Jour., Feb. 15, 1913, p. 396.
[b] For description, see Met. and Chem. Eng., Jan. 1912, pp. 27–31.
[c] See Parmelee, H. C., Zinc ore dressing in Colorado: Met. and Chem. Eng., Oct., 1910, pp. 568–570.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
DENVER COUNTY—con.				*Short tons.*
Western Chemical Mfg. Co. (A) [a].	Denver	Roast, magnetic separation and wet concentration; sulphuric acid manufacture.	Cleveland-Knowles and Wetherill magnetic separators. 1 Dorr thickener, concentrating tables, etc. (Further description not for publication.)	100
Henry E. Wood (A)	do	General experimental.	General equipment for ore testing.	
Dewey (A)	Utah Junction.	Roasters and concentrating tables.		
DOLORES COUNTY.				
Emma (A)	Dunton	Concentration	30 stamps and tables	100
Milwaukee (I)	do	do	1 crusher, 20 stamps	60–100
Pro Patria (I)	Rico	do	Remodeled in 1913 to: 2 crushers, 2 rolls, Callow classifier, 10 Wilfley tables. Regrinding middlings in Huntington mill, Deister tables.	100
EAGLE COUNTY.				
(I)	Fulford	Amalgamation	20 stamps, crusher (partly dismantled).	60
(I)	do	Amalgamation, concentration, cyanidation.	10 stamps, 1 Wilfley table, 5 cyanide percolation tanks.	30
Eagle (A) [b] [c]	Red Cliff	Magnetic separation and wet concentration.	One 9 by 15 Blake crusher, one 7 by 16 Samson crusher, 2 sets McFarlane rolls, Bunker Hill screen, 5 Card tables, roaster, modification Ball-Norton and Cleveland-Knowles magnetic separators. (Increased 1912 from 65 to 120 tons capacity.)	120
Mayhew-Fisk (I)	do	Concentration		25
French Mountain (I)	do	Cyanidation	Crusher, rolls, cyanide equipment.	40
EL PASO COUNTY.				
"Valley Mills"	Colorado City.	do	See Teller County.	
FREMONT COUNTY.				
Empire Zinc Co. (A)	Canon City	Magnetic separation.	Publication of description not desired.	
Florence (A)	Florence	Cyanidation	See Teller County.	
GILPIN COUNTY.				
Avon (I)	Bald Mountain.	Amalgamation, concentration.	30 stamps, 1 Blake crusher, 6 Gilpin County bumpers, 1 Wilfley table.	60–100
Clear Creek Mining & Milling Co. (I).	Black Hawk	Concentration	48 canvas tables, 2 Frue vanners, 2 Wilfley tables. (Concentration of mill waste.)	
Eagle (I)	do	Amalgamation, concentration.	25 stamps, bumping tables	
Eureka (I)	Central City	do	1 Blake crusher, 10 stamps, 1 Richards classifier, 1 Fraser and Chalmers vanner, 2 Wilfley and 1 Deister tables.	50
Brooklyn (I)	Black Hawk	do	10 stamps, 1 Blake crusher, Gilpin County bumpers, Hartz jigs.	40
Oliver (A)	do	do	Stamps, plates, tables	
Polar Star (A)	do	do	Hand crusher, 40 stamps, slow drop. 8 Gilpin County bumpers. (Company also owns "Mead" and "Upper Fullerton" mills—machinery of both partly removed.	49

[a] For equipment in 1907, see Hosker, R. B., Denver works of Western Chem. Mfg. Co.: Min. Sci., Dec. 26, 1907, p. 611.
[b] See Parmelee, H. C., Zinc ore dressing in Colorado: Met. and Chem. Eng., September, 1912, pp. 527–30.
[c] See Twelfth Biennial Rept. Colorado State Bureau of Mines, 1911–12, 1913, p. 73.

List of reduction mills in Colorado in 1912, by counties—Continued..

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
GILPIN COUNTY—con.				*Short tons.*
Smith (A)	Black Hawk	Amalgamation, concentration.	1 crusher, 1 roll, 1 No. 2 Denver quartz mill, 1 Wilfley table.	12–20
Fifty (I)	do	do	80 stamps, plate amalgamation, tables.	350
Frontenac (A) [a]	do	Concentration	Blake crusher, rolls, trommels, jigs, cone thickeners, Flood classifiers, 20 Card tables, 2 tube mills, Callow tanks, 4 Deister tables.	250
U. P. R (A)	Central City	Amalgamation, concentration.	1 Blake crusher, 45 stamps (rapid drop), plates, 5 Gilpin County bumpers, 3 Wilfley tables, 1 Standard table.	150
New York (A)	Black Hawk	do	70 stamps (50 stamps, 700-pound, fast drop; 20 stamps, 1,000-pound, slow drop), amalgamation plates, 20 Gilpin County bumping tables.	150
Randolph (A)	do	Concentration	25 stamps (10 operated a short time, 1912), concentrating tables.	100
Rocky Mountain (I)	do	do	Machinery removed	
Hidden Treasure (I)	do	do	Originally 40 stamps, plates. Removed, except 10 stamps, plates, 2 Wilfley tables.	
Iron City (A)	do	do	25 stamps, Flood automatic classifiers, 5 Card, 2 Deister tables, regrinding pan and plates, 2 Callow tanks.	75
Wheeler (I)	do	do	Partly dismantled	
Tucker (A)	do	do	1 crusher, 10 stamps, jigs, 2 Wilfley tables.	50
Pioneer (B)	Apex	Amalgamation, concentration.	10 stamps (1,000-pound)	40
Evergreen (I)	do	Concentration	1 Blake crusher, 2 sets coarse and fine Denver Engineering Works rolls, one 4-compartment Richards classifier, 3 Card tables, one 4-compartment Richards pulsator jig, 1 Callow tank. Contemplate using electric power.	60
Black Hills and Denver (I).	Tolland	Amalgamation, concentration.	1 Samson crusher, 1 Elspass roller mill. Pierce amalgamator, 6 Dixon tables.	50
Smuggler (A) (A. K. R.)	Rollinsville	do	1 Blake crusher, 10 stamps, plates (60 drops per minute), 2 Gilpin County bumpers, 1 Wilfley table.	30
Perigo (I)	do	do	30 stamps, plates, 12 Gilpin County bumping tables.	100
Daisy (I)	do	do	15 stamps, tables	50
Golden Flint (A)	do	do	25 stamps, plates, Pierce amalgamator, Card tables. This mill abandoned in 1912, and new mill, with rolls, tube mill, Card tables, cyanide agitation tanks, commenced in 1913.	100
Champion (I)	do	do	10 stamps	30
Northwestern (I)	Tolland	do	5 stamps, 1 Card table	12
Penobscot (I)	Rollinsville	Amalgamation	10 stamps, plates, Gilpin County bumpers, 1 Standard table.	30
GUNNISON COUNTY:				
Abe Lincoln (I)	Box Canyon	Concentration	10 stamps, tables	30
Camp Bird (I)	do	Amalgamation, concentration.	1 crusher, 10 stamps, 2 Wilfley tables.	30
Maple Leaf (A)	Cochetopa	do	8 stamps, plates, 4 Wilfley tables.	30
Lucky Strike (I)	Elk Mountain	Concentration, amalgamation, cyanidation.	1 crusher, 5 stamps, Bartlett concentrating table, canvas tables, 2 cyanide tanks.	10
Blaine (I)	do	Concentration	10 stamps, tables	30
Washington (I)	do	Amalgamation	Stamps, plates	5

[a] See Min. Sci., July 20, 1911, p. 53.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
GUNNISON COUNTY—continued.				*Short tons.*
Carter (I)	Ohio	Amalgamation, concentration.	1 crusher, 20 stamps, plates, home-made classifier, Wilfley tables.	100
Gold Links (A)	do	do	Stamps, plates, rolls, Wilfley tables.	200
Raymond (A)	do	do	1 Blake crusher, 20 stamps, plates, 4 Card, 4 Wilfley, and 1 Roberts tables.	100
Revenue (A) (Ohio)	do	Cyanidation	20 stamps, 9 cyanidation tanks, 3 agitation tanks, 2 filters.	140
Sandy Hook (I)	do	Amalgamation	1 crusher, 10 stamps, 1 Flood classifier, 1 Wilfley, and 3 Card tables.	50
Black Queen (I)	Marble	Concentration	1 Blake, 1 Dodge crusher, 1 McFarlane roll, one 6 by 8 tube mill, 6 Wilfley tables.	25
Cortlandt (I)	Pitkin	do	10 stamps, tables	30
Brunswick (I)	Tin Cup	do	1 crusher, 20 stamps, screen, tables.	80
Akron (I)	Whitepine	do	Jigs and tables	.....
Doctor (I)	do	do	2 jigs	.....
Enterprise (I)	Dorchester	do	Crusher, Wilfley tables, 1 Frue vanner.	200
West Gold Hill (I)	Tin Cup	Cyanidation, without concentration.		70
HINSDALE COUNTY.				
Gallic (I) [a]	Galena	Concentration	1 Blake crusher, McFarlane rolls, 1 concentrating table, 1 jig, trommels.	15
Golden Fleece (I) [b]	do	do	Rolls, 2 Huntington mills, Wilfley tables, canvas plant.	100
Hidden Treasure (A) [c]	do	do	1 Blake crusher, rolls, 8 Wilfley, 1 Card, and 1 other table, 2 jigs.	100
Moro (A) [d]	do	do	1 crusher, 2 Huntington mills, 10 slime-settling tanks, 10 Wilfley tables, three 2-compartment jigs. Contemplating electrostatic installation.	100–125
Planet (I) [e] (Lellie)	do	do	Crusher, rolls, Wilfley tables.	30
Ute and Ulay (I) [f]	do	do	1 Blake crusher, 3 sets Allis-Chalmers rolls, 16 by 30, 4 trommels, four 2-compartment jigs, 3 hydraulic sizers, 5 jigs.	90–100
JEFFERSON COUNTY:				
School of Mines (E)	Golden	Experimental ore dressing. Sampling, concentration, cyanidation, roasting and special apparatus (magnetic electrostatic separators, dry tables, flotation processes.	For plans of equipment, see Twelfth Biennial Report, Colorado State Bureau of Mines, 1911–1912, 1913, pp. 81–89. Also, see Min. Sci., Dec. 29, 1910, p. 626.	50
LAKE COUNTY:				
American Zinc Extraction Co. (I) [g]	Leadville	Magnetic and wet concentration.	White-Howell furnaces, Cleveland-Knowles separators, Richards classifier, Wilfley and Ford tables.	100–125

[a] See Irving and Bancroft, Geology and ore deposits near Lake City, Colo.: Bull. U. S. Geol. Survey No. 478, p. 73.
[b] Idem, p. 111.
[c] Idem, p. 94.
[d] Idem, p. 116.
[e] Idem, p. 82.
[f] Idem, p. 95.
[g] See Min. and Sci. Press, Jan. 6, 1912, p. 80.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
LAKE COUNTY—contd.				*Short tons.*
Helena (I)	Leadville	Concentration	Crusher and jigs	20
Leadville District (A)[a]	do	do	Blake crusher, rolls, trommels, 4 Hartz jigs, classifiers, 4 Card tables.	100
Belle of Granite (A)	Granite	Amalgamation, concentration.	25 stamps, 2 Wilfley tables	40–100
Miller (A)	Twin Lakes	do	1 crusher, 15 stamps, 3 Wilfley tables.	50
Mount Champion (C)	do	do	1 crusher, one 14 by 5 foot tube mill, 1 Richards classifier, 2 slimers, 2 concentrating tables. Contemplate adding cyanide equipment.	40
MESA COUNTY:				
Pyramid (I)	Sindbad Valley.	Leaching	1 Samson crusher, 2 Humphrey rolls, screens; crushed to 20 mesh, treated with sulphuric acid, then deposited on iron. Ore tanks for leaching, 3 revolving drums, 6 oblong tanks, 6 round tanks. Plant uncompleted.	200
MINERAL COUNTY:[b]				
Amethyst (A)	Creede	Concentration	One 9 by 15 Blake crusher, two 5-foot Chilean mills, trough classifier, trommels, rolls, Hartz jigs, 15 Card tables, canvas tables, Callow tanks.	150
Humphrey (A)	do	do	Crusher, coarse and fine rolls, trommels, twelve 4-compartment Hartz jigs, 3 Chilean mills, trough hydraulic classifier, 12 Wilfley tables.	250–300
Ridge (A)	North Creede	do	1 set McFarlane rolls, trommels, three 4-compartment Hartz jigs, 3 Wilfley tables.	50
MONTEZUMA COUNTY:				
Doyle (B)	La Plata	Cyanidation	10 stamps, roaster, cyanide equipment.	50
OURAY COUNTY:				
Barstow (A)	Red Mountain	Concentration	2 Blake crushers, 40 stamps (1,050 pounds), homemade classifiers, 16 Wilfley tables, 1 Wilfley slimer.	200
Treasury Tunnel (I)	do	Amalgamation, concentration.	1 Blake crusher, 20 stamps (90 to 100 drops per minute), 2 cone classifiers, 8 Wilfley tables, 2 Wilfley slimers.	80
Yankee Girl (I)	do	Concentration	Grizzlies, screens, jigs, concentrating tables.	150
Atlas (A)	Sneffels	do	1 Krom crusher, 20 stamps (1,050-pound), plates, 5 Caetani classifiers, 5 Wilfley and 6 Deister tables, Callow settlers, Frue vanners, canvas plant.	120
Camp Bird (A)[c] (2 mills.)	do	Amalgamation, concentration, cyanidation.	4 crushers, 60 stamps (1,050-pound), 5 sets of rolls, silver-covered copper plates, classifiers, 24 Frue vanners, Huntington mills, 11 Wilfley tables, cyanide mill, 16 percolation tanks.	250
Revenue (A)	do	Amalgamation, concentration.	Crushers, 60 stamps, 6 Huntington mills, jigs, Wilfley tables.	300

[a] See Mines and Minerals, May, 1912, p. 619.
[b] See Parmelee, H. C., Zinc ore dressing in Colorado; the Creede district; Metall. and Chem. Eng., December, 1910, pp. 677–680.
[c] See Min. and Sci. Press, Dec. 31, 1911, p. 866.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
OURAY COUNTY—contd.				*Short tons.*
Torpedo-Eclipse (I)	Sneffels	Amalgamation, concentration.	1 crusher, 10 stamps (850-pound), classifiers, 3 Wilfley tables.	30
Thistledown (I)	do	Concentration	Crusher, rolls, jigs, concentrating tables.	
American (Wanakah) (A).	Uncompahgre.	Amalgamation, concentration.	1 Blake crusher, 20 stamps (950-pound), 2 grinding pans, 1 Dimmick classifier, Pierce amalgamator, 1 Deister table, 9 Wilfley tables, 1 Card table. Contemplate increasing to 100 tons.	80
Mickey-Breen (A) (Haagsma-Hall).	do	Concentration	Blake crusher, 2 sets Fraser and Chalmers rolls, 1 Huntington mill, 3 classifiers, 5 Wilfley tables, 2 Frue vanners.	30
Mineral Farm (A)	do	do	20 stamps (750-pound), 6-compartment Richards classifier, 2 Card and 2 Wilfley tables, 5 vanners.	60
O. & N. (A)	do	Amalgamation, concentration.	One 3½-foot Huntington mill, plates, Wilfley tables.	25
Foerster (A) (Custom.)	do (Ouray City.)	Concentration (Separation.)	4 Huff electrostatic separators.	30
PARK COUNTY.				
Paris (A)	Buckskin	Amalgamation, concentration, cyanidation.	1 Comet gyratory crusher, 20 stamps (1,000-pound), plates, 4 Frue vanners, 4 "B. & M." percolation tanks.	60
Morning Star [a]	Consolidated Montgomery.	Amalgamation, concentration.	40-ton mill ore bin, 4 by 8 grizzly, 7 by 10 Blake crusher, 50-ton crushed ore bin, 4 Nissen feeders, 4 Nissen stamps (1,750-pound), four 30-inch by 10 amalgamating plates. Mercury trap, 30-inch cone classifier, 40-inch cone classifier, 4 Wilfley tables, 2 Horn slimers. Building 1913.	
PITKIN COUNTY.				
Tam O'Shanter (I) [b]	Ashcroft	Concentration	2 Davis mills, one 12-foot Denver Engineering Works tube mill, trommels, Hartz jigs, 6-compartment Richards classifier, 2 Wilfley and 3 Card tables, Callow tanks.	100
Little Annie (I)	Aspen	do	1 Blake crusher, 10 stamps (500-pound), 2 Woodbury slimers, 1 Hallet table, 3 double and 1 single Hartz jig, classifier.	50
Smuggler (A)	do	do	Crusher, rolls, Hartz jigs, pulverizers, classifiers, tables.	125
PUEBLO COUNTY.				
U. S. Zinc Co. (A)	Pueblo	Magnetic separation.	Publication of description not desired.	
SAGUACHE COUNTY.				
Bonanza (A)	Kerber Creek	Concentration	1 Samson crusher, Gilbert classifier, 6 Card tables.	50
Kortright (A) (Custom.)	do	do	1 Dodge (7 by 11) crusher, 2 Colorado Iron Works roller mills, 1 homemade classifier, 1 Wilfley and 1 Rittenger table, jigs.	20
Rawley (I)	do	do	1 crusher, 2 roller mills, jigs, 8 Wilfley tables.	100

[a] Building, 1913. [b] See Mines and Minerals, March, 1912, pp. 492–494, for description of mill.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
SAN JUAN COUNTY.				*Short tons.*
Aspen (A)	Animas	Concentration	Jigs, tables, vanners, trommels; roll crushing classifiers, Wilfley tables, and regrinding in Chilean mill, Frue vanners, canvas tables.	150
Gold Tunnel (I)	do	do	Crusher, rolls, trommels, jigs, Chilean mill, Wilfley tables, Frue vanners.	100
Green Mountain (I)	do	do	Crusher, rolls, jigs, trommels, 10 Card tables.	100–180
Hamlet (I)	do	do	1 crusher, 2 Huntington mills, jigs, 5 Wilfley tables.	75
Hercules (I)	do	Amalgamation, concentration.	Blake crusher, rolls, trommels, jigs, Wilfley tables; 40 stamps, plates, Wilfley tables, Frue vanners.	140
Intersection (A)	do	do	1 Blake crusher, 10 stamps (750-pound), 1 classifier, 2 Frue vanners, 1 Wilfley, and 1 Overstrom table.	30
Iowa (A)	do	do	1 Blake crusher, 3 Chilean mills, 3 Watson classifiers, 11 Wilfley tables, canvas plant, Huntington mills, vanners.	150
Silver Lake (A)	do	Concentration	Same flow sheet as Aspen mill.	300
Kittimac (I)	do	do	1 Blake, 1 Samson, crusher, rolls, classifiers, 16 Card tables. Contemplate installation of Huff electrostatic separators and also cyanidation.	100
North Star (I)	do	Amalgamation, concentration.	20 stamps, tables	70
Old Green Mountain (A).	do	Concentration	1 Blake crusher, 10 stamps (800-pound, 110 drops per minute), 3 Wilfley tables, 1 jig, 1 trommel.	25
Old Hundred (I)	do	Amalgamation, concentration.	40 stamps, plates, tables, Huntington mills, vanners.	200
Frisco (B) [a]	Eureka	Concentration	Chilean mills, classifiers, concentrating tables.	150
Gold King (A)	do	Concentration, amalgamation.	Gates crusher, 80 stamps (950-pound), plates, 32 Card tables, 4 tube mills. Amalgamation not used 1912.	240
Gold Prince (I)	do	do	2 Gates crushers, 100 stamps (1,100-pound) plates, Richards classifiers, 14 Wilfley and 40 Card tables, 5 tube mills.	400
Ledge (A) [b]	do	Concentration	Blake crusher, rolls, trommels, Hartz jigs, Chilean mill, Callow tanks, Richards classifier, 20 Wilfley tables.	125
Sound Democrat (I)	do	Amalgamation, concentration.		30
Mogul (I)	do	Concentration	Crusher, rolls, jigs, Wilfley tables, roaster.	
Silver Wing (I)	do	Concentration		100
Sunnyside (A)	do	Amalgamation, concentration, and electrostatic separation.	1 crusher, 40 stamps (1,050-pound), 2 Richards classifiers, plates, 17 Wilfley tables, 4 Deister tables, Ruggles-Coles drier, trommels, Huff electrostatic machine installed 1912.	120
Vermilion (A) [a]	do	Concentration	Crusher, rolls, trommels, Hartz jigs, Chilean mill, Richards classifier, Callow tanks, 2 Card tables.	75
SAN MIGUEL COUNTY.				
Alta (A)	Iron Springs	do	1 crusher, 30 stamps (850-pound and 1,050-pound), 10 Wilfley tables, 10 Frue vanners, 1 James vanner.	150
Butterfly (A)	do	Amalgamation, concentration.	1 crusher, 30 stamps (1,050-pound), plates, 3 hydraulic classifiers, 9 Frue vanners.	75

[a] See Eng. and Ming. Jour., June 22, 1912, p. 1244. [b] See Met. and Chem. Eng., October, 1911, pp. 487–489.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
SAN MIGUEL COUNTY—continued.				*Short tons.*
Carribeau (I)	Iron Springs	Concentration	20 stamps concentrating tables.	45
Calumet (A) (Lake Superior-Ophir.)	do	Amalgamation, concentration.	1 Blake crusher, 20 stamps (1,050-pound), plates, 4 Wilfley tables.	100
Ophir (A) [a]	do	Cyanidation	1 crusher, 20 stamps (850-pound), 1 Hardinge tube mill, 1 Dorr classifier, 5 Dorr thickeners, 2 Dorr agitators. Continuous decantation. Remodeled from amalgamation and concentration.	150
Silver Bell (I)	do	Amalgamation, concentration.	1 crusher, 50 stamps, 18 vanners, 3 concentrating tables, 1 bumper table.	150
Florence L. (I)	Lower San Miguel.	Cyanidation	10 stamps, cyanide equipment.	30
Gertrude (I)	do	Concentration, cyanidation.	10 stamps, cyanide equipment.	40
Silver Pick (I)	Mount Wilson	Concentration	10 stamps, concentrating tables	25
Cimarron (A)	Upper San Miguel.	Amalgamation, concentration.	20 stamps (1,080-pound), Blake crusher, Richards classifier, 8 Wilfley tables.	120
Columbia (Iona) (I)	do	do	30 stamps, plates, concentrating tables.	150
Japan-Flora (I)	do	Concentration	Rolls, trommels, jigs, Wilfley tables.	50
Junta (A)	do	Amalgamation	1 crusher, 2 Denver quartz mills, 1 Wilfley table.	10
Lewis (A)	do	Concentration	1 crusher, 2 sets rolls, 1 tube mill, 1 Richards classifier, 1 Johnson vanner, 2 Frue vanners, 5 Wilfley tables, 2 Richards jigs.	50
Liberty Bell (A) [b] [c]	do (Pandora.)	Amalgamation, cyanidation, concentration.	2 Blake crushers, 80 stamps (850-pound), amalgamation in sodium cyanide solution. 3 Abbe tube mills, 4 Richards, 1 Akins, 2 Dorr classifiers, Dorr agitator, 12 cones, 18 Wilfley and 10 Deister tables. 7 Dorr thickeners, 6 agitators, 8 storage tanks. Moore vacuum-filter plant. In 1913 installed plant for cyanidation of concentrates by fine grinding and agitation by Dorr continuous decantation.	500
Mammoth (I)	do	Concentration	1 Blake crusher, 10 stamps (1,050-pound), 2 Frue vanners.	40
Nellie (A)	do	Amalgamation, concentration.	5 stamps, plates, Wilfley tables	20
Smuggler and Pandora. (2 mills) (A). [b] [c]	do	Amalgamation, cyanidation, concentration.	140 stamps (1,040-pound), rolls, jigs, 2 tube mills, 18 Callow tanks, 4 Akins classifiers, 8 Dorr thickeners, 16 Frue vanners, 43 Triumph vanners, 24 Wilfley tables, 106 canvas tables, 6 percolation, 4 agitation tanks (15,000 tons per month), 5 Portland filters. Slime plant added in 1912.	700
Argentine (A) [c] [d] (Tomboy.)	do	Amalgamation, concentration.	1 Kennedy crusher, 60 stamps, (1,050-pound), 2 Hardinge tube mills, 4 Bunker Hill screens, 3 Akins classifiers, 12 Frue vanners, 34 Wilfley and 9 Deister tables, 4 Dorr thickeners, Moore filters, Ding electromagnetic separator (not used).	350

[a] See Eng. and Min. Jour., Feb. 15, 1913, p. 380, for flow sheet.
[b] See Twelfth Biennial Rept. Colorado State Bureau Mines, 1911–1912, 1913, pp. 70, 80.
[c] See Min. and Sci. Press, Mar. 11, 1911, p. 360; also Eng. and Min. Jour., Jan 4, 1913, p. 9.
[d] See Eng. and Min. Jour., Apr. 5, 1913, p. 730, for changes.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
SUMMIT COUNTY.				*Short tons.*
Arctic (I)	Breckenridge	Amalgamation, concentration.	10 stamps, 3 concentrating tables.	40
Excelsior (I)	Frisco	Concentration	Crusher, rolls, Wilfley tables	50
Laurium (Blue Flag) (A).	Breckenridge	do	1 Symons gyratory crusher, 2 Tatman roller mills, 1 classifier, 4 Wilfley tables.	65
Lucky (I)	do	do	1 Blake crusher, 2 sets rolls, trommels, 1 Wilfley table, four 4-compartment jigs.	50
Old Union (I)	do	do	Crusher, rolls, 8 Hartz jigs, 10 Wilfley tables.	100
Wellington (A) [a]	do	Concentration, magnetic separation, and wet concentration.	Crushers, 4 sets Morse rolls, 2 Henderson classifiers, Callow screens, six 6-compartment Hartz jigs, 13 Wilfley and 3 Card tables, 1 Deister table, roasting and Ball-Norton magnetic separator completed in 1912.	90–100
Bolivar (B)	Montezuma	Concentration	2 crushers, 1 Traylor roller mill, 4 Wilfley tables, 1 jig, Huntington mill.	35–40
Colorado-Toledo (I) [b]	do	do	1 No. 5 Austin gyratory crusher, small crusher, 2 rolls, jigs, screens, Flood classifiers, 5 Card tables.	.....
Pennsylvania (I)	do	do	1 Blake, 1 Krom crusher, 2 Chilean mills, 1 Akron, 2 McFarlane rolls, jigs, and trommels. Flood classifiers. 19 Card tables, Callow tanks.	150
Plymouth (I)	do	do	1 Century crusher, Faust jigs, 3 sets rolls, 3 Wilfley tables, crude sliming tanks.	100
St. John (I)	do	do	Gates crushers, rotary screens, rolls, Faust jigs, sizer, 4 Ford tables, settling tanks.	600
Kimberley-Wilfley (I)	Kokomo	Magnetic separation and wet concentration.	2 roasters, Ding magnetic separators, Wilfley tables. Uncompleted.	250
Kokomo Metal Co. (I)	do	do	Ding magnetic separators, Wilfley roasters, Wilfley tables.	.....
International (A) [c] (Robinson.)	do	do	2 Symons No. 5 gyratory crushers, Fairchild dryer, 3 rolls, 1 Richards classifier, 5 Dewey (circular multiple hearth) roasters, 5 Fairchild magnetic separators, 10 Wilfley, and 2 Card tables.	250
TELLER COUNTY. *Mills in Cripple Creek district.*				
Colburn-Ajax (A)	Cripple Creek	Concentration, cyanidation.	Remodeled equipment, June, 1913: 1 gyratory, 1 disk crusher, 3 sets rolls, 2 tube mills, 3 Dorr, 2 Akins, 3 home-made classifiers, 6 Card tables, 1 Wilfley table, 5 Pachuca type tanks—160 tons capacity, 1 unit Moore filter. Experimenting in 1912 with modified Clancy process.	300
Anaconda (I)	do	Cyanidation	1 Blake crusher, 1 Davis and 6 Cartonville roller mills. 6 percolation tanks.	75
Blue Flag (A) [d]	do	do	One 18-inch disk crusher, 1 Dodge crusher, Symons rolls, 6 agitation tanks, 4 Dorr thickeners; continuous decantation. (Changed from leaching to agitation).	150
Dante (A) (Gaylord.)	do	do	1 gyratory, 1 jaw crusher, 2 rolls, 6 percolation tanks. Leaching process.	75

[a] See Min. and Eng. World, Dec. 23, 1911, pp. 1165–1266; also Parmelee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., September, 1912, pp. 527–530.
[b] See Min. and Sci. Press, Feb. 18, 1911, pp. 261–262.
[c] See Metall. and Chem. Eng., February, 1911, pp. 91–95.
[d] See Eng. and Min. Jour., Feb. 15, 1913, p. 380.

List of reduction mills in Colorado in 1912, by counties—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
TELLER COUNTY—con.				
Mills in Cripple Creek district—Continued.				*Short tons.*
Homestake (I) (Rex).	Cripple Creek.	Cyanidation	Crusher and tanks	50
Jo Dandy (A) (Kavanaugh).	do	do	Blake crusher, 2 sets rolls, trommel screen, 4 percolation tanks.	100
Isabella (A)	do	do	Five 50-ton tanks—coarse crushing. Solution left in tanks longer than usual custom.	100
Little Giant (I)	do	do	Completed but never operated. Some of the machinery removed.	50
Portland (A) [a]	do (At Victor).	Concentration, cyanidation.	Blake crusher, Symons disk crusher, rolls, Vezen sampler, four 6-foot Akron Chiloan mills, 42 Wilfley tables, 4 Akins classifiers, sands and slimes products—sands to Akins classifiers, slimes to thickening cones—card tables. Dorr and Akins thickeners, air agitators, Portland filters, Merrill zinc-dust precipitation.	350
Stratton's Independence (A) [b].	do	do	3 Gates gyratory crushers, 4 Chiloan mills, 1 tube mill, 5 Ovoca classifiers, 4 Allis-Chalmers vanners, 22 Card and 13 Deister tables, 6 agitation and 6 percolation tanks, 2 Cassell filters.	350
Wild Horse (A)	do	Cyanidation	1 crusher, 2 rolls, 4 cyanide tanks.	40
Mills treating Cripple Creek ore.				
Golden Cycle (A) [c]	Colorado City.	Roast-cyanidation. (Subsidiary amalgamation.)	Sampler, 6 ball mills, 9 Edwards roasters, seven 6-foot Chiloan mills, blanket tables, 9 Dorr classifiers, 4 Dorr thickeners, percolation tanks, vacuum and slime filters.	1,000–1,200
Portland (A)	Colorado Springs.	Cyanidation, concentration.	2 Blake crushers, 2 Stearns-Rogers, 6 Colorado Iron Works rolls, 3 tube mills, 1 Wilfley table, Dorr classifiers and thickeners, blanket concentration, 4 percolation, 2 agitation tanks (mechanical mixers), 2 Merrill filters.	350
Standard (I) (U. S. R. & R.)	Colorado City.	Chlorination, concentration, cyanidation.	2 Blake crushers, 8 Allis-Chalmers rolls, 6 tube mills, 4 Dorr classifiers, 20 Wilfley tables, 6 iron percolation tanks, 8 tanks (1,500 tons), for cyanidation in all. Cyanide addition to Standard plant, called Colorado plant. Original Colorado chlorination plant idle since 1903 and dismantled 1912. Clean-up of all plants was made in 1912.	350
Florence (A) (U. S. R. & R.)	Florence	Cyanidation	Original plant, chlorination, operated 1901–1908. 2 crushers, 7 Davis rolls, 20 Wilfley tables, auxiliary cyanide plant (capacity 500 tons), for treatment of old tailings, tube mills (blankets), 4 Dorr thickeners, Merrill presses, precipitation by zinc dust.	600

[a] For description, see Twelfth Biennial Rept. Colorado State Bureau Mines, 1911–1912, 1913, pp. 71–72.
[b] See Min. Mag. (London), Dec., 1911; also Min. and Sci. Press, Jan. 6, 1912, p. 78.
[c] For description, see Twelfth Biennial Rept. Colorado State Bureau Mines, 1911–1912, 1913, pp. 67–69.

Mills in Colorado, according to processes used, and classified as active, idle, experimental, building, or completed, in 1912.

Process.	Active.	Idle.	Experimental.	Building.	Completed.	Total.
Amalgamation	4	8				12
Amalgamation and concentration	33	34	2	4	1	74
Amalgamation and cyanidation	2					2
Amalgamation, concentration, and cyanidation	5	2			1	8
Amalgamation, concentration, and electrostatic separation	1			1		2
Chlorination	1	1				2
Chlorination, concentration, and cyanidation		1				1
Concentration	34	58		2		94
Concentration and cyanidation	5	3		1		9
Cyanidation	10	13	1			24
Dry concentration				1		1
Electrostatic separation	1					1
General experimental			2			2
Leaching		1				1
Magnetic separation	2					2
Magnetic separation and wet concentration	4	3				7
Tungsten concentration	6	2				8
Total	108	126	5	9	2	250

Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver contained in bullion produced in Colorado in 1912, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Boulder	4,058	1,070.02	577	222
Clear Creek	40,798	3,158.07	4,473	42,934
Custer	3,500	562.43	2,785	
Dolores				1,987
Eagle		6.38		28,258
Gilpin	40,771	5,505.58	1,417	62,767
Gunnison	12,793	2,955.14	2,079	529
Hinsdale				9,220
Lake	845	1,743.90	750	80,087
La Plata		237.47	85	
Mineral				36,520
Ouray	56,593	22,963.84	10,269	30,051
Park	264	57.64	19	
Pitkin				55,103
Rio Grande		21.96		
Saguache				8,699
San Juan	44,774	4,661.25	1,876	89,522
San Miguel	418,886	72,589.08	305,614	35,600
Summit		130.22	44	41,564
Teller	812,555	429,087.95	30,502	
Total, 1912	1,435,837	544,750.93	360,490	523,063
Total, 1911	1,373,879	598,820.48	401,603	465,283
Increase (+) or decrease (−)	+61,958	−54,069.55	−41,113	+57,780
Average content per ton		0.379	0.25	

Fineness of Colorado bullion in 1912, by counties.

[In thousandths.]

County.	Gold.	Silver.	County.	Gold.	Silver.
Boulder	733	177	Montrose	809	181
Chaffee	812	135	Ouray	495	245
Clear Creek	725	250	Park	815	176
Custer	143	710	San Juan	729	256
Gilpin	784	171	San Miguel	187	721
Gunnison	571	403	Summit	781	195
Lake	741	218	Teller	848	58
La Plata	686	258			

Mine production of gold, silver, copper, lead, and zinc from Colorado concentrates in 1912, by counties.

County.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	54	71.33	236	104	132	.....
Clear Creek	9,669	6,681.33	119,868	121,948	1,751,011	1,505,454
Dolores	341	205.75	18,225	77	129,879	111,256
Eagle	7,467	82.70	7,318	128	537,791	5,601,609
Gilpin	24,095	16,932.60	201,927	494,282	1,209,246	25,377
Gunnison	2,045	2,981.04	11,873	1,917	172,184	230,027
Hinsdale	1,433	187.88	20,551	36,048	1,204,781	11,926
Lake	69,230	2,066.98	420,491	128,579	9,753,360	23,690,826
Mineral	5,014	3,322.53	37,340	10,846	4,355,366	308,681
Ouray	16,234	26,661.95	344,548	353,684	2,530,171	140,667
Pitkin	14,129	.....	71,444	22,018	5,956,600	.....
Saguache	1,096	66.78	9,484	7,084	424,357	510,528
San Juan	20,693	17,406.71	291,480	643,978	7,704,249	2,373,321
San Miguel	31,154	43,170.42	777,452	832,675	6,828,462	2,943,783
Summit	17,264	390.21	76,116	4,514	3,535,366	8,600,499
Teller	4,804	13,600.40	7,161	.....	.....	.....
Total, 1912	224,722	133,828.61	2,415,514	2,657,882	46,092,955	46,053,954
Total, 1911	201,010	109,817.43	1,967,545	2,611,779	44,863,551	41,262,830
Increase (+)	+23,712	+24,011.18	+447,969	+46,103	+1,229,404	+4,791,124
Subdivision by kinds of concentrates:						
Dry or siliceous	47,165	56,431.61	390,592	717,373	1,568,884	.....
Copper	43	121.02	646	2,965	.....	.....
Lead	108,516	70,901.79	1,852,586	1,352,733	42,271,843	.....
Zinc	61,278	5,454.88	95,823	551,559	1,280,870	41,188,340
Copper-lead	127	10.55	2,128	17,680	50,776	.....
Lead-zinc	7,593	908.76	73,739	15,572	920,582	4,865,614
		Fine ounces per ton.	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Average content:						
Dry or siliceous	.....	1.196	8.28	0.76	1.66	.....
Copper	.....	2.814	15.02	3.45	.....	.....
Lead	.....	0.653	17.07	0.62	19.48	.....
Zinc	.....	0.089	1.56	0.45	10.45	[a] 39.87
Copper-lead	.....	0.083	16.76	6.96	19.99	.....
Lead-zinc	.....	0.120	9.71	0.10	6.06	[a] 36.91

[a] Crude assay; no deduction for loss in smelting.

Mine production of gold, silver, copper, lead, and zinc from Colorado crude ore shipped to smelters in 1912, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	5,558	4,635.89	71,522	22,072	305,690	.....
Chaffee	10,287	4,492.59	104,647	133,570	992,578	736,392
Clear Creek	19,162	11,709.87	249,599	327,453	1,772,722	229,039
Custer	830	255.01	22,641	2,006	10,444	.....
Dolores	6,498	159.77	82,063	689,838	1,082,521	700,773
Eagle	5,906	2,294.55	156,417	147,048	702,365	57,652
Fremont	1,015	12.24	3,439	35,903	55,956	447,507
Gilpin	15,114	21,317.25	112,861	531,488	142,354	.....
Gunnison	724	95.03	15,056	6,180	134,683	253,857
Hinsdale	334	141.60	14,171	17,691	53,019	.....
Lake	426,659	49,557.87	2,579,156	1,937,221	16,480,884	82,254,957
La Plata	2,761	6,312.07	47,863	918	6,756	.....
Mesa	22	.44	257	5,685	20	.....
Mineral	29,968	837.82	677,569	13,039	1,374,856	.....
Moffat	64	.....	124	25,085	.....	.....
Ouray	3,331	1,148.13	190,360	46,868	458,873	.....
Park	2,422	2,301.01	31,026	10,321	167,756	132,275
Pitkin	36,688	7.98	457,060	934	2,448,733	484,507
Rio Grande	133	246.51	896	29,673	313	.....
Saguache	760	117.29	9,825	22,395	80,488	24,400
San Juan	6,621	3,259.93	421,618	419,313	1,410,085	105,273
San Miguel	1,210	303.44	70,643	12,822	601,160	.....
Summit	5,042	1,089.29	83,693	11,898	867,056	742,226
Teller	36,617	82,717.86	22,860	.....	.....	.....
Total, 1912	617,726	193,013.43	5,425,366	4,449,421	29,149,312	86,168,858
Total, 1911	538,774	188,997.49	4,954,076	5,412,709	24,815,738	53,344,626
Increase (+) or decrease (−)	+78,952	+4,015.94	+471,290	−963,288	+4,333,574	+32,824,232
Subdivision by kinds of ore:						
Dry or siliceous	343,128	165,278.64	3,439,958	1,964,531	5,658,652	.....
Copper	13,851	8,737.87	224,327	1,622,605	102,321	.....
Lead	80,091	16,912.17	1,286,554	290,841	18,891,317	.....
Zinc	154,412	92.88	11,445	22,302	115,789	78,185,797
Copper-lead	6,810	1,936.59	389,449	531,227	1,260,482	.....
Lead-zinc	19,434	55.28	73,633	17,915	3,120,751	7,983,061
		Fine ounces per ton.	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Average content:						
Dry or siliceous	.....	0.482	10.03	0.29	0.82	.....
Copper	.....	0.631	16.20	5.86	0.37	.....
Lead	.....	0.211	16.06	0.18	11.79	.....
Zinc	.....	0.001	0.07	0.01	0.04	[a] 29.51
Copper-lead	.....	0.284	57.19	3.90	9.25	.....
Lead-zinc	.....	0.003	3.79	0.05	8.03	[a] 25.05

[a] Crude assay; no deduction for loss in smelting.

Tonnage of ore and old tailings to amalgamation, cyanidation, and chlorination mills, with quantity of gold and silver contained in bullion and precipitates, in Colorado, in 1912, by processes.

Quantity.	Process.	Gold in bullion.	Silver in bullion.
Short tons.		*Fine ounces.*	*Fine ounces.*
[a] 1,638,400	Amalgamation	93,282.73	10,622
	Cyanidation	[b] 458,591.49	355,462
1,638,400		551,874.22	366,084

[a] Of this quantity, 619,452 tons were treated by amalgamation, in some cases followed by cyanidation of tailings and in other cases not followed by cyanidation; in some cases crushing in cyanide solution. Many of the mills have not record of tonnage of tailings treated by cyanidation.

[b] Includes very small quantity recovered by chlorination.

Consumption of quicksilver and cyanide in Colorado mills in 1912.

Quicksilver.	Potassium cyanide.	Sodium cyanide.
Pounds.	*Pounds.*	*Pounds.*
[a] 10,622	[b] 464,930	[b] 372,607

[a] Represents 1 pound of mercury for every 58.3 tons of ore and 1 pound of mercury for every 8.78 ounces of gold.
[b] Represents in combined potassium and sodium cyanide 1 pound of cyanide for every 0.55 ounce gold and 0.42 ounce silver, or to recover 1 ounce gold and practically 1 ounce silver required 1.83 pounds of cyanide.

REVIEW BY COUNTIES.[1]

BOULDER COUNTY.

Production of gold, silver, copper, and lead in Boulder County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*		
1904	52	23,905	$388,482	97,228	5,340	.....	$444,815	$18.61
1905	31	9,577	261,601	70,921	2,227	.....	304,784	31.83
1906	44	5,528	188,769	21,923	3,539	47,491	206,847	37.42
1907	38	8,000	161,658	23,480	22,840	16,491	182,597	22.82
1908	38	10,296	147,234	21,498	28,955	96,503	166,503	16.17
1909	56	13,188	163,273	48,183	16,485	425,605	208,772	15.83
1910	85	14,083	139,911	46,517	16,772	53,250	169,503	12.04
1911	115	15,816	163,174	53,753	27,752	145,955	201,700	12.75
1912	126	9,838	119,426	72,335	22,176	305,822	181,333	18.43
Increase (+) or decrease (−)	+11	−5,978	−43,748	+18,582	−5,576	+159,867	−20,367	+5.68

Boulder County in 1912 produced 9,838 tons of ore, yielding $119,426 in gold; 72,335 ounces of silver, valued at $44,486; 22,176 pounds of copper, valued at $3,659; 305,822 pounds of lead, valued at $13,762; a total value of $181,333, a decrease for 1912 of $20,367. The chief metal product of this county is gold, in which there was a heavy decrease. Silver, second in importance, showed a considerable increase, and the lead yield also increased.

The tonnage of both milling and smelting ore decreased heavily. The smelting ore contained the greater part of the metals produced, although the tonnage to smelters was a little more than half the total tonnage from the county.

Central district.—The production of the Central district (near Jamestown) was 461 tons, with a total value of $17,145 (chiefly lead, with gold and silver following in order), as compared with $11,381 (chiefly gold) in 1911. All the ore went to smelters, except a very small quantity of high-grade gold ore sent to a small custom chlorination plant at Boulder. The producing mines were the Argo, Earl, Eureka, Gladiator, Golden Cross, Golden Harvest, Maybelle, Oro Fino, Little Ethel, Rip Van Dam, Tippecanoe, and Wano group.

[1] For discussions of the geology of the districts mentioned in the following pages the reader is referred to the bibliography appended to this report and to Survey Bulletin 507: The mining districts of the western United States, by J. M. Hill, with a geological introduction by Waldemar Lindgren, 1912.

Gold Hill district.—The Gold Hill district continued to be the chief producing district in Boulder County, with an output of 6,540 tons of ore, yielding $58,932 in gold, 18,762 ounces of silver, 2,441 pounds of copper, and 56,889 pounds of lead, with a total value of $73,434, as compared with $98,472 in 1911. There were 41 producing mines in 1912, as against 51 in 1911. Mill bullion contained about one-sixth of the gold and crude ore and concentrates the remainder of the metals produced in the district.

Three mills were operated part of the year and various lots of high gold content were treated by chlorination at Boulder. The principal producing mines were the Alaska, American Star, Big Six, Black Cloud, Cash-Birkin, Chivington, Clarence, Emerson, Fairfax, Fortune Dyke, Granite, Ingram, Inter-Ocean, Little Johnny, Nil Desperandum, Nugget, Prussian, Rainbow, Richmond, Sherman and Harp, Slide, Sunshine, Temple, Victoria, and White Crow.

Grand Island district (*Cardinal, Caribou, Eldora, Nederland*).—In this district, 6 mines in 1912 produced 205 tons of ore yielding a total value of $2,911, chiefly silver. A small quantity of bullion was recovered from ore of the Battle Ax mine treated at the Alton mill, and the rest of the metals were contained in crude ore and in a few tons of concentrates. Other producing mines were the Caribou, Hawkeye, Lost Lake, Wigwam, and Up-To-Date.

Magnolia district.—The Magnolia district in 1912 yielded $16,461 in gold and 266 ounces of silver, with a total value of $16,625, as against $13,359 in 1911. Ore from the Cash mine was treated by cyanidation. Other producing mines were the American, Fortune, Graphic, Hereafter, Kansas City, Keystone, Ophir, Poorman, and Sac & Fox. Most of the ore was gold telluride of good commercial value.

Sugar Loaf district.—The Sugar Loaf district produced 814 tons, yielding $13,806 in gold, 28,880 ounces of silver, 3,177 pounds of copper, and 13,470 pounds of lead, with a total value of $32,697, as compared with $38,290 in 1911. The bulk of the ore was shipped to smelters. The free-milling ore of the Logan mine was treated in a small laboratory plant or sold to a custom chlorination plant at Boulder; in addition a good grade of smelting ore was shipped. Gold telluride ore was shipped from the Alpine Horn mine. A small quantity of bullion was recovered from the treatment of ore from the Doss, Little Maxine, and Orphan Boy mines. The other principal producing mines were the Blue Bird, Cyclops, Dime, Evening Star, Livingstone, Milwaukee, Smoky Hill, Sunset, Tambourine, Two Brothers, and Yellow Pine. The U. S. Gold Corporation's 150-ton cyanide plant was completed.

Ward district.—The Ward district in 1912 produced 808 tons, yielding $18,825 in gold, 13,932 ounces of silver, 11,226 pounds of copper, and 36,574 pounds of lead, with a total value of $30,891, as compared with $32,434 in 1911. Some ore from the Utica Hill group was tested in the cyanide mill on the property, and ore from the Blue Coat mine was treated at the Boston mill. Ore from the Camp Talcott, Celestial Extension, Lois, White Raven, and Big Five Co. mines was shipped to smelters.

CHAFFEE COUNTY.

Production of gold, silver, copper, lead, and zinc in Chaffee County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	14	12,777	$69,818	49,874	456,556	458,422	.....	$175,497	$13.74
1905	15	13,408	32,378	75,265	379,722	1,250,302	315,495	214 453	14.87
1906	16	14,134	57,965	54,609	349,466	1,227,019	717,703	275,720	15.97
1907	14	14,592	75,364	38,465	799,505	630,623	2,091,489	417,473	16.47
1908	16	8,772	49,057	35,745	337,804	1,040,238	703,706	189,356	17.68
1909	27	10,214	30,485	35,477	568,868	584,492	947,741	199,197	17.59
1910	26	12,496	77,152	182,003	226,772	970,523	438,539	270,618	20.29
1911	19,	7,459	65,714	92,098	88,448	1,001,651	200,509	182,085	23.60
1912	19	10,287	97,489	104,686	133,570	992,578	736,392	279,387	26.71
Increase (+) or decrease (−)	.....	+2,828	+31,775	+12,588	+45,122	−9,073	+535,883	+97,302	+3.11

[a] Includes placer production.

Deep mines in Chaffee County in 1912 produced 10,287 tons of ore, yielding $92,870 in gold, 104,647 ounces of silver, valued at $64,358; 133,570 pounds of copper, valued at $22,039; 992,578 pounds of lead, valued at $44,666; and 736,392 pounds of zinc, valued at $50,811, with a total value of $274,744, as compared with $182,085 in 1911. Placer mines in 1912 yielded $4,619 in gold and 39 ounces of silver as compared with $5,893 in gold and 47 ounces of silver in 1911. In 1912 all the ore was sent direct to smelters.

There were 16 productive deep mines and 3 placers. The Chalk Creek district output, valued at over twice that of 1911, took first place in point of output, while the yield of the Monarch district remained practically the same. The output of the Turret copper district increased heavily in 1912 on account of the reopening of mines which shipped zinc carbonate.

Chalk Creek district.—Shipments of lead ore from the Chalk Creek district again increased heavily. The principal mine is the Mary Murphy, the ore of which is a sulphide (in part slightly oxidized) of zinc, lead, iron, and copper, in a gangue of quartz and rhodonite carrying gold and silver. The zinc is under the penalty limit, and the ore was shipped in the crude state in 1912, but in 1912-13 a mill was built for concentration, with subsidiary amalgamation and electrostatic separation of zinc, iron, and copper. Lead and lead-zinc ore was shipped from the Black Hawk mine, dry ore, carrying gold and silver, from the Baalbec; and dry ore, carrying gold, silver, and lead, from the Flora Bell mine.

Four Mile district.—A small yield of placer gold was made from the Derillo placer on Arkansas River, near Four Mile Creek.

Granite district.—The Twin Lakes Placer Co., prior to 1911 an important producer of placer gold by hydraulicking, having been enjoined in 1911 from polluting the water of Arkansas River, confined its operations to shoveling gravel into sluice boxes.

Monarch district.[1]—The Monarch district in 1912 was second to the Chalk Creek district in point of output. From 10 mines were shipped

[1] Crawford, R. D., Geology and ore deposits of the Monarch and Tomichi districts, Colorado: Bull. Colorado State Geol. Survey No. 4, 1913.

5,972 tons, yielding $12,092 in gold, 62,792 ounces of silver, 73,474 pounds of copper, 592,591 pounds of lead, and 388,306 pounds of zinc, with a total value of $116,292, as compared with $117,262 in 1911.

The Madonna mine was again the chief producer,[1] with a decrease in lead ore shipments but an increase in zinc carbonate ore shipments. Oxidized lead and copper ore was shipped from the Lilly mine.[2] Zinc carbonate and dry siliceous ore was shipped from the Eclipse mine, and copper-lead oxidized ore from the New York mine, lead ore from the Last Chance and the Moose mines, copper oxidized ore from the Shamrock mine, lead and zinc carbonate from the Silent Friend mine, and lead oxidized ore from the Garfield mines.

Riverside district.—Ore carrying gold, silver, copper, and lead was shipped from the Mount Harvard mine.

Turret district (including Sedalia).—Zinc sulphide and zinc carbonate ores and also lead-zinc, lead, and copper ores were shipped from the Sedalia mine.

A small quantity of placer gold was recovered in a hand rocker from the bench gravel of the Brown Canon mine on Arkansas River.

CLEAR CREEK COUNTY.

Production of gold, silver, copper, lead, and zinc in Clear Creek County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average total value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	53	62,661	$665,459	735,985	369,778	3,753,447	2,135,302	$1,404,010	$22.37
1905	49	58,775	503,698	692,437	235,669	3,270,211	1,869,995	1,222,724	20.77
1906	71	64,774	529,753	652,796	235,375	3,307,001	1,755,805	1,308,156	20.14
1907	88	79,548	522,896	518,364	171,340	2,804,172	1,406,187	1,130,870	14.07
1908	104	109,672	659,116	503,551	264,994	2,015,010	836,411	1,084,918	9.87
1909	150	116,753	536,407	448,535	299,546	3,254,675	758,074	989,473	8.44
1910	157	109,954	522,524	475,174	595,795	2,434,476	1,247,389	1,029,260	9.33
1911	95	105,774	519,207	437,841	650,368	3,325,222	1,417,544	1,062,994	10.03
1912	91	102,894	445,794	373,940	449,401	3,523,733	1,734,493	1,028,166	9.99
Increase (+) or decrease (−)	−4	−2,880	−73,413	−63,901	−200,967	+198,511	+316,949	−34,828	−0.04

[a] Includes placer production.

The total yield of Clear Creek County in 1912 was $445,794 in gold; 373,940 ounces of silver, valued at $229,973; 449,401 pounds of copper, valued at $74,151; 3,523,733 pounds of lead, valued at $158,568; 1,734,493 pounds of zinc, valued at $119,680—a total value of $1,028,166. The bullion produced during 1912 from a slightly increased tonnage to amalgamating and cyaniding mills contained less gold but more silver than in 1911, owing to the higher percentage than in 1911 of silver compared with gold in the 1912 cyanide precipitates from Idaho Springs. A larger tonnage of concentrates contained an increased content of gold, and a materially decreased tonnage of crude ore to smelters contained proportionately less gold. The silver content of both concentrates and crude ore to smelters decreased. A heavy decrease in copper content of crude ore was not balanced by

[1] For the total output of mine, including 1911, see Crawford, R. D., op. cit., p. 239.
[2] Op. cit., p. 262.

the increased content in concentrates. Lead production was equally divided between concentrates and crude ore, with a small increase from both sources. The zinc yield was chiefly from concentrates, the content of which for 1912 showed a material increase.

The output from the Lower Clear Creek mines (Idaho, Jackson, Montana, and Trail districts combined), showed a small decrease in tonnage with decrease in the quantity of all the metals, while Upper Clear Creek mines (Argentine, Empire, and Griffith districts), showed a small increase in tonnage, an increase in quantity of gold, lead, and zinc, but a decrease in silver and copper, with an increase in combined values.

There were 88 producing deep mines or groups of mines, as compared with 91 in 1911, and from other mines and prospects a very small tonnage was produced.

Producing placers in 1912 were 3 in number, as compared with 4 in 1911. The yield of placer gold decreased from $1,754 to $331 in 1912.

The tonnage of ore sold or treated in 1912 was 102,894 short tons, as against 105,774 tons in 1911. The average value per ton in 1912 was $9.99, as compared with $10.03 in 1911.

Alice (or Yankee) district.—The output from the Alice district was $2,112, mostly gold, as compared with $1,991 in 1911. The low-grade deposit of disseminated pyrite of the Alice Gold Mills Co. was sampled, and a series of mill tests was run on ore removed in exploratory development work. A small tonnage from the Little Lalla mine was treated by amalgamation. Several small lots of ore from various other properties were sold to smelters or to custom milling plants.

Argentine district.—The Argentine district, from 7 mines, produced 1,840 tons, yielding $17,487 in gold, 34,447 ounces of silver, 85,578 pounds of copper, 739,356 pounds of lead, and 32,580 pounds of zinc, with a total value of $88,311, as compared with $99,992 in 1911.

The principal producing mine was again the Santiago, from which was shipped copper-lead ore carrying appreciable quantities of gold and silver. Crude ore was shipped to smelters from the Commonwealth, Harris, Josephine, Kittie Owsley, and Mary Etta mines.

Empire (or Upper Union) district.—The Empire district in 1912, from 11 mines, produced 2,162 tons of ore, yielding $20,722 in gold, 7,381 ounces of silver, 8,266 pounds of copper, 83,382 pounds of lead, and 4,241 pounds of zinc, with a total value of $30,670, as compared with $24,736 in 1911. More than two-thirds of the ore was milled, but crude ore to smelters contained more than half of the metal output. Lead-zinc ore from the Bard Creek mines was concentrated at the Linn mill, at Georgetown. Ore from the Empire-Mint mine was milled at the company's amalgamation and concentration mill. The ore from the Gold Dirt mine, the principal producer, was sold to smelters and to custom milling plants, as was also the ore from the Gold Fissure and Pioneer mines. Ore from the Tennessee mine was milled or smelted. Shipments of crude ore to smelters were made also from the Anamosa, Bellevue-Hudson, Golconda, and Pittsburg mines.

Georgetown (Griffith, Silver Plume) district.—The Georgetown district in 1912, from 16 mines, produced 44,429 short tons of ore, yielding $82,546 in gold, 133,953 ounces of silver, 74,495 pounds of copper,

1,528,592 pounds of lead, and 1,578,497 pounds of zinc, with a total value for the five metals of $354,922, as compared with $261,286 in 1911. The output of ore in 1912 was 4,228 tons greater than in 1911. Gold, copper, lead, and zinc increased, but silver decreased. Zinc production from this district represented 91 per cent of the value of the county yield.

Lead-zinc ore from the Boston mine was treated at the Linn mill. The Capital mine was operated steadily, with an increased output. Not only was ore milled at the company plant at Georgetown, but lessees shipped to custom milling plants at Idaho Springs, and an increased tonnage of smelting ore was shipped. Dump and mine ore from the Corry City-Scotia property was milled at the Nashotah mill. Crude and dump ore from the Dives-Pelican-Seven-Thirty group was treated at the Burleigh mill and at the Scotia mill, the output being lead and zinc concentrates. Crude lead and zinc ore were also shipped direct to smelters. Lead-zinc ore from the Mendota-Frostburg group was treated at the Mendota concentration mill, the product being lead concentrates, zinc concentrates, and a zinc-iron middling. Lead-zinc ore from the Smuggler mine was treated at the Mendota mill or sent to smelters. Lead-zinc ore from the Gambetta mine was milled at various plants at Georgetown and Idaho Springs, and also sent crude to smelters. Lessees operated the Mineral Chief mine and mill (Linn), lead and zinc concentrates being marketed. Lead and lead-zinc concentrates and ore were marketed from operations by lessees on the Scotia mine. Small lots of smelting ore were shipped from the Richmond, Scott, Wide West, and West Griffith mines.

Idaho Springs district.—In this district are included the mines about Idaho Springs, including Banner, Cascade, Coral, Jackson, Lower Fall River, Payne's Bar, Spanish Bar, and Virginia subdistricts.

In 1912 there were 46,074 tons of ore mined in the Idaho district, as compared with 51,637 tons in 1911. The production of metals from deep mines in 1912 was $257,813 in gold, 161,681 ounces of silver, 255,061 pounds of copper, 897,341 pounds of lead, and 13,435 pounds of zinc, with a total value for the five metals of $440,639, as compared with $509,358 in 1911.

In 1912, of the 46,074 tons mined, 21,051 tons were treated at amalgamating, cyaniding, and concentrating mills, and 13,999 tons were treated at mills for concentrating only, a total to both classes of mills of 35,050 tons, yielding 4,575 tons of concentrates (ratio 7.7 to 1). These concentrates and 12,322 tons of crude ore, 16,897 tons in all, were shipped to smelters, and contained all the metals produced by deep mines in the district (with the exception of 1,490.45 fine ounces of gold, valued at $30,810, and 3,582 fine ounces of silver, valued at $2,203, in amalgation bullion and cyanide precipitates).

Through the Big Five tunnel, ore from the Edgar, East and West Belman, Edith S., Lake, Refugee, and Shafter mines was shipped to smelters or to various custom amalgamating, cyaniding, and concentrating mills. Ore from the upper levels of the Specie Payment mine was sent to Black Hawk mills, and ore from the lower levels was trammed through the Two Brothers tunnel and sent to custom plants at Idaho Springs or to smelters. In Virginia Canyon, the Blue Bell, Crystal, Papoose, Treasure Vault, and Victor mines were producers.

Through the Newhouse tunnel, the principal producing property was the Gem Consolidated mines, from which a materially increased tonnage was sent to mills and smelters. A considerable tonnage of ore from mines in Gilpin County was trammed through the Newhouse tunnel and sold or treated at Idaho Springs. The recovered metals from this ore are accredited to Gilpin County. Ore from the Franklin and the Freeman mines, in Gilson Gulch, was shipped to mills and smelters. A small tonnage was mined in the Foxhall tunnel, and lead-zinc ore from the Bride mine (worked through the Idaho tunnel) was milled at the Gem mill, and crude lead ore, lead and iron concentrates, and zinc middlings were sent to smelters. On the south side of Clear Creek the Little Mattie group was the principal producer, most of the ore being treated at the company's mill. A material quantity of ore from the Gladstone mine was concentrated or sent to smelters. A greatly reduced tonnage was mined from the Stanley mines. Small shipments of ore were sent to mills and smelters from the Kitty Clyde and Lincoln mines. Several lots were shipped from the Almaden mine, on Fall River.

In the Jackson and Cascade districts, producing mines were the Beaver, Black Eagle, Humboldt, and P. T.

Montana (Dumont and Lawson) district.—The Montana district in 1912, from 8 mines, produced 598 tons, carrying $2,487 in gold, 20,087 ounces of silver, 425 pounds of copper, and 85,405 pounds of lead, with a total value of $18,754, as compared with $12,688 in 1911. Lead and dry ores were shipped to smelters from the Albro, Blue Ridge, Commodore, Cymric, Millington, Platts-Lawson, and Two American Sisters mines. Both milling and smelting ores were shipped from the Syndicate mine.

Trail Creek (Lamartine and Freeland) district.—The Trail Creek district in 1912, from 8 mines, produced 7,490 tons, yielding $62,364 in gold, 16,295 ounces of silver, 25,576 pounds of copper, 189,467 pounds of lead, and 105,740 pounds of zinc, with a total value of $92,427, as compared with $151,175 in 1911. Lead-zinc ore from the Ben Harrison mine was concentrated at the Jackson mill, yielding lead and lead-zinc concentrates. Milling and smelting ores were shipped from the Lamartine-Money-Musk group. The yield from the Centurion, Donaldson, Harrison, Rockford, and other properties of the North American Smelter & Mines Co., was considerably less than in 1911, the output for 1912 being both milling and smelting ores. Ore from the Oneida mine was sent to custom mills or to smelters. An increased tonnage was mined from the New Era mine, the most of the ore being treated at the company's mill and part being shipped to smelters.

ORE SELLING.

The following new smelting schedule [1] became effective July 1, 1912:

Schedule for ores and concentrates, Clear Creek, Gilpin and Boulder District, effective July 1, 1912.

[All rates f. o. b. cars Denver. Lots to contain not less than one carload. Subject to change without notice.]

Upon all classes of ore:

Gold, $19 per ounce if 5–100 ounce to 2 ounces per ton; $19.50 if over 2 ounces per ton.

Silver, 95 per cent of the New York quotation, date of assay, when ore assays 2 ounces or over per ton.

[1] See also new Colorado smelting schedules: Eng. and Min. Jour., Sept. 14, 1912, p. 509.

Upon all classes of ore—Continued.

Copper, for dry copper (1.5 off wet) to 5 per cent dry, 6 cents off Western Union quotation for casting copper. Over 5 per cent to 10 per cent dry, 5 cents off quotation; over 10 per cent dry, 4 cents off quotation.

Zinc, limit 10 per cent: Penalty 50 cents per unit over 10 per cent.

$14 gross value and under, $5 treatment.
Over $14 to $20 gross value, $6 treatment.
Over $20 to $25 gross value, $6.50 treatment.
Over $25 to $30 gross value, $7 treatment.
Over $30 to $35 gross value, $7.50 treatment.
Over $35 to $40 gross value, $8 treatment.
Over $40 to $45 gross value, $8.50 treatment.
Over $45 to $50 gross value, $9 treatment.
Over $50 gross value, $10 treatment.

Pay 25 cents per unit for lead if 5 per cent or over.

Apply to lead ores "Neutral Schedule" or "Flat Schedule" of July 1, 1912, if either figures better for shipper than above schedule.

Apply to dry ores, $7 treatment charge, neutral basis, 10 cents up or down, when this figures better for shipper than the "Flat Schedule."

Dry concentrates:

Gold, silver, and copper as above.
Silica (insoluble matter) 10 per cent limit; 10 cents up.
Zinc, 5 per cent limit; 30 cents up.
$35 gross value and under, $3.50 treatment.
Over $35 to $80 gross value, $4 treatment.
Over $80 gross value, $4.50 treatment.

The maximum treatment charge upon concentrates, including silica penalty but not zinc penalty, shall not exceed the maximum charge upon crude ores of the same grade.

Schedule for lead ores and concentrates: Clear Creek and Gilpin counties, July 1, 1912.

[All rates f. o. b. cars Denver. Subject to change without notice. Lots to contain not less than one carload.]

Lead ores:

Gold, $19.50 per ounce if 0.05 ounce or over per ton.
Silver, 95 per cent of the New York quotation, date of assay.
Lead, prices based upon $4 per 100 pounds.
Copper, for dry copper (1.5 off wet) 6 cents off Western Union quotation for casting copper.
Zinc, 10 per cent limit; penalty 50 cents per unit over 10 per cent.

Neutral schedule.

5 to 10 per cent lead, inclusive	40 cents per unit;	$6.00 working charge.
Over 10 to 15 per cent lead, inclusive	43 cents per unit;	5.00 working charge.
Over 15 to 20 per cent lead, inclusive	45 cents per unit;	4.00 working charge.
Over 20 to 25 per cent lead, inclusive	47 cents per unit;	3.00 working charge.
Over 25 to 30 per cent lead, inclusive	49 cents per unit;	3.00 working charge.
Over 30 to 35 per cent lead, inclusive	51 cents per unit;	2.00 working charge.
Over 35 to 40 per cent lead, inclusive	52 cents per unit;	1.50 working charge.
Over 40 to 45 per cent lead, inclusive	52 cents per unit;	1.00 working charge.
Over 45 to 50 per cent lead, inclusive	53 cents per unit;	1.00 working charge.
Over 50 to 55 per cent lead, inclusive	54 cents per unit;	1.00 working charge.
Over 55 per cent lead	55 cents per unit;	1.00 working charge.

Neutral basis, 10 cents up or down.

Flat schedule.

5 to 10 per cent lead, inclusive	40 cents per unit;	$10.00 working charge.
Over 10 to 15 per cent lead, inclusive	43 cents per unit;	8.50 working charge.
Over 15 to 20 per cent lead, inclusive	45 cents per unit;	7.00 working charge.
Over 20 to 25 per cent lead, inclusive	47 cents per unit;	5.50 working charge.
Over 25 to 30 per cent lead, inclusive	49 cents per unit;	4.50 working charge.
Over 30 to 35 per cent lead, inclusive	51 cents per unit;	3.50 working charge.
Over 35 to 40 per cent lead, inclusive	52 cents per unit;	2.00 working charge.
Over 40 to 45 per cent lead, inclusive	52 cents per unit;	1.00 working charge.
Over 45 to 50 per cent lead, inclusive	53 cents per unit;	1.00 working charge.
Over 50 to 55 per cent lead, inclusive	54 cents per unit;	1.00 working charge.
Over 55 per cent lead	55 cents per unit;	1.00 working charge.

"Neutral schedule" to be used when it figures better for shipper.
Lead concentrates:
Gold, $19 per ounce if 0.05 ounce to 2 ounces per ton; $19.50 if over 2 ounces.
Silver and copper, as in lead ores.
Lead, prices based on $4.
Silica, limit 10 per cent; 10 cents up.
Zinc, limit 10 per cent; 50 cents up.

5 to 10 per cent lead, inclusive	40 cents per unit;	$3.75 working charge.
Over 10 to 15 per cent lead, inclusive	43 cents per unit;	3.00 working charge.
Over 15 to 20 per cent lead, inclusive	45 cents per unit;	2.50 working charge.
Over 20 to 25 per cent lead, inclusive	47 cents per unit;	2.25 working charge.
Over 25 to 30 per cent lead, inclusive	49 cents per unit;	2.25 working charge.

Upon concentrates assaying over 30 per cent lead, apply "neutral schedule" or "flat schedule," whichever figures better for shipper; gold, $19 per ounce up to 2 ounces; $19.50 if over 2 ounces per ton.

LEAD QUOTATION.

The prices paid per unit for lead in all ores and concentrates are based upon a quotation of $4 per 100 pounds, 1 cent up or down for each change of 5 cents in the quotation.

The quotation used as a basis of settlement shall be figured as follows from the New York sales price of the American S. & R. Co. on date of settlement: When the sales price does not exceed $4 per hundredweight, take 90 per cent of the sales price. When it does exceed $4, add to $3.60 per hundredweight one-half of the excess of the New York sales price above $4.

The following is the schedule for treatment at the Argo cyanide mill.[1]

Argo reduction and ore-purchasing works.

TREATMENT SCHEDULE.

Gold, pay $19 per ounce, if 0.05 ounce to 1.5 ounces per ton. Pay $19.50 per ounce, if 1.5 ounces and over per ton.
Silver, pay New York quotation, date of assay, for 60 per cent of the silver assay, if 1 ounce and over per ton.
Lead, deduct 2 per cent from the fire assay and pay 25 cents per unit for the balance.
Copper, deduct 1.5 per cent from the wet assay and pay $1 per unit for the balance.
Zinc, no pay; no penalty.
Sampling, no charge for 12-ton lots and over; $1 per ton for less than 12-ton lots.

TREATMENT CHARGES.

Gross value of ore per ton.	Charge per ton.	Gross value of ore per ton.	Charge per ton.
Up to $3	$2.00	Over $14 to $20	$5.00
Over $3 to $4	2.50	Over $20 to $25	5.75
Over $4 to $5	3.00	Over $25 to $30	7.00
Over $5 to $6	3.25	Over $30 to $35	8.00
Over $6 to $7	3.50	Over $35 to $40	9.00
Over $7 to $8	3.75	Over $40 to $45	9.50
Over $8 to $9	4.00	Over $45 to $50	10.00
Over $9 to $10	4.25	Over $50 to $75	11.00
Over $10 to $11	4.50	Over $75	12.00
Over $11 to $14	4.75		

CONEJOS-RIO GRANDE COUNTIES.

Platoro-Gilmore-Summit district.[2]—Prospecting and some development work was done in the reopening of this district, which is 45 miles southwest of Monte Vista, near the Rio Grande-Conejos County line.

[1] Goodale, Stephen L., The Argo cyanide mill, Idaho Springs, Colo.: Eng. and Min. Jour., Aug. 30, 1913, p. 389.
[2] Emmons, W. H., The enrichment of sulphide ores (Summit district, Colo.): Bull. U. S. Geol. Survey No. 529, 1913, p. 226.
A vistor's estimate of Platoro: Eng. and Min. Jour., Aug. 9, 1913, p. 258; see also Eng. and Min. Jour., May 17, 1913, p. 996.

COSTILLA COUNTY.

Grayback district.[1]—The Colorado Gold Dredging Co.'s Hammond dredge of the close connected type, of 54 buckets of 4 cubic feet capacity each, which was overturned in 1911, was not in operation in 1912. A little gold was recovered by sluicing in the district. Assessment work was done on several lode prospects.

CUSTER COUNTY.

From 8 mines in Custer County in 1912 there were sold or treated 4,330 tons of ore, from which were recovered $16,898 in gold; 25,426 ounces of silver, valued at $15,637; 2,008 pounds of copper, valued at $331; and 10,444 pounds of lead, valued at $470, a total value of $33,336, as compared with $13,538 in 1911. All the metals except lead increased in value.

With the exception of several lots of lead and copper ores, the tonnage was dry or siliceous ore. The greater part of the ore was milled and the remainder was shipped to smelters.

Crude gold-silver ore was shipped to smelters from the Bassick mine, and lessees treated old tailings from the dump in a 35-ton cyanide plant. Smelting ore was shipped from the Hector and from the Whistle mine, at Rosita, and from the King of the Carbonates, Maxine Elliott, S. A. K., Troy, and Vanderbilt mines, at Westcliffe.

Some development work was done on the copper-lead-zinc sulphide ore body[2] of the Marion Mines & Mill Co., at Fairview, 45 miles southwest of Pueblo. The mill was idle.

DOLORES COUNTY.

Production of gold, silver, copper, lead, and zinc in Dolores County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average total value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904.....	10	7,727	$41,391	100,194	12,201	260,584	145,060	$118,928	$15.39
1905.....	5	3,826	34,766	76,526	119,821	840,319	1,500,000	227,675	59.51
1906.....	8	2,242	9,398	34,290	199,379	118,229	22,506	78,964	35.22
1907.....	8	1,575	11,689	33,037	99,495	54,547	12,649	57,029	36.21
1908.....	5	11,024	37,238	163,563	42,495	947,962	509,184	193,281	17.53
1909.....	10	4,787	22,266	103,646	43,538	462,373	167,574	110,753	23.14
1910.....	13	2,933	15,327	88,309	97,063	127,909	87,000	85,667	29.21
1911.....	12	3,276	7,565	56,202	3,288	701,244	525,333	99,263	30.30
1912.....	7	8,485	7,556	100,288	689,915	1,212,400	812,029	293,658	34.60
Increase (+) or decrease (−).....	−5	+5,209	−9	+44,086	+686,627	+511,156	+286,696	+194,395	+4.30

Dolores County in 1912 produced 8,485 short tons of ore, yielding $7,556 in gold; 100,288 ounces of silver, valued at $61,677; 689,915 pounds of copper, valued at $113,837; 1,212,400 pounds of lead, valued at $54,558; and 812,029 pounds of zinc, valued at $56,030,

[1] See Julian, Charles, Gold dredging in Costilla County, Colo: Min. Sci., May 25, 1911, pp. 540–542. Also, Patton, Smith, Butler, and Hoskins, Geology of the Grayback mining district, Costilla County, Colo.: Bull. Colorado State Geol. Survey for 1909, No. 2, 1910.

[2] See Parmalee, H. C., Zinc-ore dressing in Colorado: Metall. and Chem. Eng., Oct., 1910, pp. 566–570.

with a total value of $293,658, as compared with $99,263 in 1911. The gold yield remained stationary, but there were large increases in both quantity and value for the other metals.

Lone Cone (Dunton) district.—The Emma mine was again the only important producer in this district. The ore from this mine carries chiefly gold and silver, and the greater part was concentrated in the company's mill, the remainder being shipped to smelters. A small lot of copper ore was shipped from the Rosebud mine.

Pioneer (Rico) district.—This district in 1912 produced 6,819 short tons of ore, yielding $1,316 in gold, 68,794 ounces of silver, 689,139 pounds of copper, 1,207,535 pounds of lead, and 812,029 pounds of zinc, with a total value of $267,702, as compared with $77,125 in 1912. The ore was lead, lead-zinc, and copper, and all was shipped from the district, the bulk of the ore going to smelters near Salt Lake City, and some to Durango, Pueblo, and Salida. Some of the ore shipped to Midvale, Utah, was concentrated by electrostatic separators and some to the Western Chemical Co., Denver, was concentrated by magnetic and wet milling. The Rico-Wellington group was the principal producing property. The public report of this company states:

> That ore production consisted of lead ore, 463 tons, worth $11,477; copper ore, 4,596 tons, worth $79,657; zinc ore, 1,068 tons, worth $20,389; a total value of $111,523. * * * Development covered 3,822 feet, and about 11,000 tons of lead-zinc ore is ready for mining. * * * The Pro Patria mill, belonging to the Rico Mining Co., has been leased for five years; $30,000 is being spent on remodeling the mill and power plant.[a]

Other producing mines were the Badger, Lillian D., Rico Argentine group, and Rico Mining Co. group.

DOUGLAS COUNTY.

A small quantity of placer gold was recovered by sluicing in Newlins Gulch, near Parker, in Douglas County, in 1912.

EAGLE COUNTY.

Production of gold, silver, copper, lead, and zinc in Eagle County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[b]	Silver.[b]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	10	1,866	$30,460	21,011	27,042	323,969	3,080	$60,195	$32.26
1905	9	12,049	46,891	46,487	29,331	156,723	2,915,025	258,897	21.47
1906	16	15,986	51,561	94,912	130,233	307,755	1,065,082	222,799	13.94
1907	15	4,191	53,641	70,586	14,270	193,690	507,949	143,317	34.20
1908	10	3,009	58,131	86,715	66,141	11,204	.....	113,292	37.62
1909	16	11,526	53,308	125,214	286,885	152,280	740,408	202,244	17.45
1910	13	27,761	25,231	88,313	209,551	397,409	4,147,945	341,008	12.27
1911	11	33,177	41,160	116,109	66,608	855,889	5,097,597	440,102	13.26
1912	19	34,164	49,294	163,735	147,176	1,240,156	5,659,261	620,571	18.16
Increase (+)	+8	+987	+8,134	+47,626	+80,568	+384,267	+561,664	+180,469	+4.90

Eagle County, in 1912, produced 34,164 short tons of ore containing $49,294 in gold; 163,735 ounces of silver, valued at $100,697; 147,176 pounds of copper, valued at $24,284; 1,240,156 pounds of lead, valued

[a] Min. & Sci. Press, Mar. 8, 1913, p. 392.

[b] Includes placer production.

at $55,807; and 5,659,261 pounds of zinc, valued at $390,489, a total value of $620,571, as compared with $440,102 in 1911. There were material increases in all the metals, particularly in zinc. The county maintained its place as third in the production of zinc. There were 19 producing mines, 1 of which was a placer, as against 10 deep mines and 1 placer in 1911. Both the tonnage shipped to separating mills and to smelters increased.

Battle Mountain district.—An increased quantity of lead-zinc ore from the Iron Mask group was treated at the company's 80-ton magnetic separation mill, yielding a lead and a zinc concentrate. The lead concentrate carries a little gold and silver. The crude ore milled carries about as follows: 1 to 5 per cent lead, 17 per cent zinc, 30 per cent iron, 26 per cent sulphur, and 2 per cent silica.[1] Lessees on the Ground Hog mine shipped siliceous gold-silver ore and copper ore. Dry, lead, and lead-zinc ore was shipped from the Bleak House mine. Other mines from which ore was shipped were the Ben Butler, Eastern County, Eclipse, Foster Combination, Pine Martin, Star of the West, Tip Top, and Wyoming.

Edwards (Mount Egley district).—A test lot of lead ore was shipped from the Mattie mine.

McDonald district.—A small quantity of gold was recovered by sluicing from the Sunday placer, on Grand River, near McCoy.

Girard Mountain district.—A small lot of copper ore was shipped from the Black Tiger mine.

FREMONT COUNTY.

Shipments of copper-lead and zinc-sulphide ore were made from Cotopaxi.

GILPIN COUNTY.

Production of gold, silver, copper, lead, and zinc in Gilpin County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	55	109,557	$1,104,833	355,354	604,791	125,731	113,000	$1,395,023	$12.73
1905	66	182,873	1,450,033	340,901	512,276	519,841	191,574	1,771,588	9.69
1906	90	114,662	1,115,902	242,478	638,002	510,791	.....	1,430,611	12.48
1907	84	87,887	938,488	209,347	874,060	611,060	.....	1,283,855	14.58
1908	112	120,761	1,075,808	187,030	636,371	538,143	.....	1,281,537	10.61
1909	244	111,118	887,311	172,010	499,146	664,581	.....	1,070,222	9.63
1910	162	83,631	687,902	132,635	534,244	575,477	.....	852,695	10.19
1911	162	103,038	778,774	292,659	950,240	1,239,356	23,088	1,109,750	10.77
1912	151	118,652	904,505	316,205	1,025,770	1,351,600	25,377	1,330,796	11.22
Increase (+) or decrease (−).	−11	+15,614	+125,731	+23,646	+75,530	+112,244	+2,289	+221,046	+0.45

[a] Includes placer production.

Gilpin County in 1912 produced 118,652 short tons of ore, as against 103,038 tons in 1911. There were 101 companies or individuals operating deep mines or groups of mines, and there were 50 small lots of ore produced from other properties, making a total of 151 mines from which ore was derived.

[1] Hanington, C. H., Twelfth Biennial Rept. State Bureau of Mines, 1911–12, 1913, p. 73.

The output of gold was $904,505; the silver yield was valued at $194,466; copper, $169,252; lead, $60,822; and zinc, $1,751, a total value of $1,330,796, as compared with $1,109,750 in 1911.

The tonnage sent to amalgamating mills in Gilpin County (and to amalgamating, cyaniding, and concentrating mills at Idaho Springs) increased materially, with a consequent increase in gold-silver bullion and precipitates. The tonnage to mills for concentration increased slightly, but shipments of crude ore direct to smelters decreased.

The Polar Star and U. P. R. custom amalgamation-concentration mills were operated continuously, the Frontenac concentration mill was operated steadily on Frontenac ore, the Iron City concentration mill was operated on custom ore, the Oliver mill was operated for a short time, and the Smith mill was operated on crude and dump ore. The Randolph and New York mills were operated for a short period only, the operations being in the nature of "clean-up."

Almost all the ore of Gilpin County is dry siliceous, there being some ore carrying copper above 2½ per cent and a small tonnage of ore carrying lead above 4½ per cent. Concentrating ore in 1912 made practically all dry siliceous concentrates, there being some lead concentrates produced and also a few cars of zinc concentrates. The average value per ton of Gilpin County ore in 1912 was $11.22, of which $7.62 was for gold. In 1911 the average value was $10.77, of which $7.56 was for gold.

Southern area (Central City, Black Hawk, Nevadaville, Russell Gulch).—The old districts of the main area of Gilpin County are so indefinite that separation of output by districts has been abandoned.

In the immediate vicinity of Central City, producing mines were the Corydon, Huddleston, and Troublesome.

In the Enterprise district, below Black Hawk, producing mines were the Coaley, Little Kingdom, and Mohaska.

Producing mines in the district embracing Gunnell Hill and Eureka and Prosser gulches, were the Buckley, Bullion, Gilpin-Mohawk, Gunnell group, and Ready Cash.

Producing mines in the district embracing the town of Black Hawk and the Gregory, Bobtail, and Bates Hills were the After Supper, Americus, Banzai, Bates, Cicero, Dump Lode, Gettysburg, Gilpin-Orion, Klein-German, Morning Star, Nehema, O. K., Running Lode, Senator, U. P. R., and Whitesides.

Producing mines in the district embracing Illinois and Leavenworth gulches and the east portion of Quartz Hill were the Alps, East and West Calhoun, East Missouri, Egyptian, Gladstone, Gauntlet, Harsh, Kirk, and Wood. In this district, pitchblende has been mined from time to time at the Wood, Kirk, Alps, Calhoun, and German and Belcher mines.

The principal producing mines in the Lake Gulch district were the New National Tunnel group, the Pittsburg, and the West Notaway mines.

In the vicinity of Nevadaville, among producing mines were the Alger-Kansas, Columbia Tunnel group, Dyke, Edinburg, Hubert, Illinois, Kansas-Burroughs, Ralls County, Roderick Dhu, San Juan, Shanks Tunnel, and West Baker. The Dyke mine was worked from the Newhouse tunnel level and the ore shipped via Idaho Springs, but the contents have been credited to Gilpin County. Some zinc concentrates were recovered from the milling of ore from the Hubert mine.

In the Quartz valley district, producing mines were the Hayseed Tunnel and the Margaret Glennon.

The Russell Gulch district is the most important in Gilpin County. Among the producing mines were the Aurora, Chase, Denbigh, Druid, Federal, Frontenac, Gulch, Hall, King Bee, Lotus, Pewabic, Old Town group, Rockford, Saratoga, Square Deal (East Notaway), Topeka, Two Forty, and War Dance.

Northern districts.—The outlying districts in Gilpin County are the Vermilion district, 4 miles northwest of Central City; Pine district, 7 miles northwest of Central City; Independence and Union districts, 9 miles north of Central City, embracing Perigo and Rollinsville, Lump Gulch, and Moon Gulch sections; Phoenix district, along the North edge of the county, near the Boulder County line; and Silver Lake district, 5 miles north of Central City.

Independence and Union districts.—The principal mines in the outside districts were near Perigo and Rollinsville. There were 6,793 tons of ore from these districts sold or treated in 1912, with a total value of $41,058, of which $39,118 was gold. Nearly all the tonnage was milled. Ore from the Smuggler and from the Golden Flint mine was treated by amalgamation and concentration. Other producing mines were the Gilpin King, Michigan, Mountain Monarch, and Star.

Pine (or Wisconsin) district.—Ore from the Eliza Jane mine was sent to smelters and also to mills at Black Hawk. A small tonnage from the London mine, in Twelve Mile Gulch, was shipped to smelters.

Silver Lake district.—Small tonnages of smelting ore were shipped from the Golden Rod and Sherman Tunnel mines.

GUNNISON COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Gunnison County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	15	2,067	$28,720	128,096	1,864	19,820	.....	$103,155	$49.58
1905	18	5,581	28,156	53,649	50,500	219,809	101,559	84,761	15.19
1906	20	31,103	87,505	70,798	.....	248,737	328,180	169,137	5.44
1907	17	18,078	61,569	27,277	13,690	120,226	68,644	92,732	5.13
1908	16	14,439	100,032	28,664	5,481	327,612	147,000	136,617	9.46
1909	18	9,071	108,493	37,423	51,815	493,070	212,093	167,344	18.45
1910	14	25,203	233,972	49,189	21,024	581,841	176,815	298,353	11.84
1911	20	11,926	145,039	32,541	9,928	631,933	557,456	223,739	18.65
1912	14	14,046	125,327	29,035	8,097	306,867	483,884	191,717	13.60
Increase (+) or decrease (−).	− 6	+ 2,120	− 19,712	− 3,506	− 1,831	−325,066	− 73,572	− 32,022	− 5.05

[a] Includes placer production.

The output from Gunnison County in 1912 from deep and placer mines was 14,046 tons of ore, yielding $125,327 in gold; 29,035 ounces of silver, valued at $17,857; 8,097 pounds of copper, valued at $1,336; 306,867 pounds of lead, valued at $13,809; and 483,884 pounds of zinc, valued at $33,388; a total value of $191,717, as compared with $223,739 in 1911. Decreases for 1912 were chiefly in gold,

lead, and zinc yields. The quantity of both silver and copper decreased, but owing to higher average values for these metals in 1912 than in 1911, they increased slightly in value. The decrease in gold was in the Cochetopa district. The lead output increased in Tomichi district and decreased in Gold Brick district, it decreased also in the Elk Mountain district (no output in 1912). The zinc output increased in the Rock Creek district but decreased in the Tomichi district.

Box Canyon district (*Waunita Hot Springs*).—There was no output from the Box Canyon district.

Cochetopa district (*Sillsville*).—There was only a small yield of bullion and concentrates from the amalgamation and concentration mill on the Maple Leaf mine at Sillsville.

Elk Mountain district (*Crested Butte*).—No output was made from this district.

Gold Brick district (*Ohio*).—This is the principal producing district in Gunnison County. The output in 1912 showed little change from that of 1911 other than a decrease in lead output. Gold is the important metal of this district. An increased tonnage was treated at amalgamating and concentrating mills, but less ore was shipped crude to smelters. The Gold Links and the Raymond mines were the chief producers.

Quartz Creek district (*Pitkin*).—There was no output from this district.

Rock Creek district (*Marble*).—Lead-zinc ore from the Lead King mine was shipped to Leadville and concentrated at the Leadville district mill.

Tin Cup district.—There was a small output, in the form of bullion, from the treatment of ore from the Gold Texas mine. Hydraulicking on the Little Mary placers resulted in the recovery of a considerable but a decreased quantity of placer gold, as compared with the yield in 1911.

Tomichi district (*Whitepine*) [1]—Lead-zinc ore from the Morning Star mine, dry siliceous gold and silver ore from the Maid of Athens mine, lead ore from the Maid of Erin mine, and copper-lead ore from the Spar mine, were shipped to smelters in 1912.

HINSDALE COUNTY.

Production of gold, silver, copper, lead, and zinc in Hinsdale County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	11	5,591	$7,692	39,283	10,530	1,054,421	101,086	$82,679	$14.79
1905	10	5,041	11,991	54,419	84,485	767,681	2,085	94,244	18.70
1906	16	7,086	24,510	87,940	63,621	753,950	30,475	140,543	19.83
1907	9	10,740	7,520	50,109	99,410	1,204,628	23,034	125,678	11.70
1908	10	980	2,454	29,498	188,698	280,465	.....	54,776	55.89
1909	10	1,697	7,587	75,731	714,569	106,327	.....	144,433	85.11
1910	12	3,468	6,320	54,422	465,472	296,182	.....	107,855	31.10
1911	6	723	3,830	7,753	21,696	118,645	36,439	18,067	24.98
1912	12	9,554	6,811	34,722	53,739	1,257,800	11,926	94,456	9.89
Increase (+) or decrease (−).	+ 6	+ 8,831	+2,981	+ 26,969	+ 32,043	+1,139,155	− 24,513	+ 76,389	− 15.09

[1] See Crawford, R. D., Geology and ore deposits of the Monarch and Tomichi districts, Colo.: Bull. Colorado Geol. Survey No. 4, 1913.

Hinsdale County in 1912, from 12 mines, produced 9,554 tons of ore, yielding $6,811 in gold; 34,722 ounces of silver, valued at $21,354; 53,739 pounds of copper, valued at $8,867; 1,257,800 pounds of lead, valued at $56,601; and 11,926 pounds of zinc, valued at $823; a total value of $94,456, as compared with $18,067 in 1911.

Galena district.—Most of the active mines in Hinsdale County are in the Galena district. The chief producing mines in 1912 were the Hidden Treasure and the Highland Chief, from which considerable tonnages of lead ore were sent to concentration mills. Ore from the Czar, the Moro, and the Yellow Medicine mines was also milled. Crude ore was shipped to smelters from the Black Crook, Excelsior, Frank Hough, Golden Wonder, Owl, and Sacramento mines.

Lake district.—Several cars of hand-sorted gold-silver ore were shipped from the Pelican mine.

LAKE COUNTY.

Production of gold, silver, copper, lead, and zinc in Lake County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904.....	66	663,487	$1,175,841	4,820,596	3,627,846	54,392,821	92,005,179	$11,369,059	$17.14
1905.....	61	648,464	1,180,401	4,033,762	3,105,710	51,162,040	64,856,033	10,332,406	15.93
1906.....	61	672,055	1,509,381	3,890,338	2,092,735	47,456,964	71,702,721	11,598,718	17.26
1907.....	70	631,273	1,064,690	4,154,913	2,679,510	32,519,796	37,412,374	8,273,714	13.10
1908.....	61	408,711	1,228,449	2,893,496	4,674,502	19,646,007	23,188,080	5,294,008	12.95
1909.....	97	417,297	1,435,431	3,423,642	5,182,608	21,073,992	38,637,315	6,882,061	16.49
1910.....	105	462,033	1,213,134	3,322,015	3,645,157	19,249,503	56,367,445	7,360,777	15.92
1911.....	94	438,419	1,133,442	3,007,296	4,017,504	18,499,089	71,610,456	8,143,752	18.58
1912.....	100	507,591	1,103,230	3,000,397	2,065,800	26,234,244	105,945,783	11,780,131	23.21
Increase (+) or decrease (−).....	+6	+69,172	−30,212	−6,899	−1,951,704	+7,735,155	+34,335,327	+3,636,379	+4.63

[a] Includes placer production.

In 1912, Lake County was first in point of value of production, although with regard to the quantity of ore shipped or treated, Teller was first, Lake County second, and San Miguel County third. The Lake County tonnage was 20 per cent and the value 32 per cent of the respective State totals. This county was again first in the production of silver, copper, lead, and zinc, and in the production of gold it followed Teller and San Miguel, taking third place from Ouray County.

Of the State output, Lake County produced 37 per cent of the silver, 35 per cent of the lead, 29 per cent of the copper, and 80 per cent of the zinc.

In 1912, from 100 deep mines, there were sold or treated 507,591 short tons of ore, yielding $1,103,230 in gold; 3,000,397 ounces of silver, valued at $1,845,244; 2,065,800 pounds of copper, valued at $340,857; 26,234,244 pounds of lead, valued at $1,180,541; and 105,945,783 pounds of zinc, valued at $7,310,259, a total value of $11,780,131. The average value per ton of the ore was $23.21 as against $18.58 in 1911.

Lake County includes the Leadville, St. Kevin's or Sugar Loaf, Twin Lakes, and Big English Gulch districts.

Leadville district (California).—Of a total of 507,591 tons of ore mined in the county 503,370 tons were from the Leadville district.

The tonnage from this district yielded $1,095,167 in gold, 2,805,429 fine ounces of silver, 2,065,491 pounds of copper, 26,148,400 pounds of lead, and 105,945,783 pounds of zinc, having a combined value of $11,648,249, out of a county total of $11,780,131. As compared with 1911 this output showed an increase in tonnage, small decreases in gold and silver yields, a material decrease in copper, but an increase in lead and a large increase in zinc. The output of zinc carbonate ore (first discovered in 1910) increased from 8,059 tons in 1910 to 83,905 tons of 31.1 per cent zinc in 1911, and to 142,782 tons of 29.2 per cent zinc in 1912. The zinc sulphide shipped increased from 79,376 tons of 23.3 per cent zinc in 1911 to 104,148 tons of 24 per cent zinc in 1912. Combined zinc and zinc-lead ores increased from 163,281 tons in 1911 to 246,930 tons in 1912.

The tonnage of iron sulphide decreased somewhat; the tonnage of lead and iron-manganese oxide ores increased; but the tonnage of siliceous oxide ores decreased. The ore sent to concentrating mills increased materially, that sent to lead smelters decreased, but tonnages to zinc smelters increased heavily.

Classification of Leadville ores.

Character.	Quantity.	Quantity.	Percentage.
Sulphide:	*Short tons.*	*Short tons.*	
Zinc-iron-lead (zinc blende: Pyrite with a little galena)	104,148	104,148	20
Iron (pyrite with a little copper, gold, silver, and lead)	127,575	140,615	28
Iron (pyrite with a little copper, gold, silver, and over 4½ per cent lead)	13,040		
Total sulphide	244,763	244,763	48
Oxide:			
Lead	23,754	24,652	5
Copper	898		
Iron-manganese (silver)	69,805	69,805	14
Zinc carbonate and silicate	142,782	142,782	29
Total oxide	237,239	237,239	48
Siliceous (oxide[a]):			
Gold-silver	21,368	21,368	4
Grand total	503,370	503,370	100

Character.	Tonnage.	Recovered contents.					Average.				
		Gold.	Silver.	Copper.	Lead.	Zinc.	Gold.	Silver.	Copper.	Lead.	Zinc.
Sulphide:	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds*	*Ozs. per ton.*	*Ozs. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Zinc-iron-lead	104,148	(b)	(b)	(b)	(b)	(c)	d0.02	d 5.55	.....	d 8.80	d 24.0
Iron pyrite	127,575	32,462.84	1,536,592	1,748,246	2,511,562	.....	0.254	12.04	0.69	0.98	.....
Lead sulphide	13,040	2,109.02	110,092	35,582	4,479,214	.....	0.162	8.44	0.14	17.17	.....
Oxide:											
Lead	23,754	4,470.20	308,363	1,331	4,931,803	.....	0.188	12.98	.....	10.38	.....
Copper	898	96.64	1,771	101,476	2,486	.....	0.108	1.97	5.65	0.14	.....
Iron-manganese (silver)	69,805	1,799.62	276,016	.....	1,702,976	.....	0.026	3.95	.....	1.22	.....
Zinc	142,782	.....	.....	.....	.....	(c)	.....	.....	.....	.....	e 29.2
Siliceous	21,368	8,233.38	108,485	47,617	366,923	.....	0.385	5.08	0.11	0.86	.....
Metallics	.....	1,657.66	716	.....	.....	.....	.....	.....	.....	.....	.....
Total	503,370	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] All the siliceous ore is also oxide and dry. Metallic gold, in quantity 1,657.66 fine ounces, valued at $34,267, and 716 fine ounces of silver came from less than a ton of ore, from siliceous oxide and sulphide ore bodies.

[b] Estimated recovery, as lead and iron concentrates and zinc residues.

[c] Zinc figured as spelter or as zinc in zinc oxide.

[d] Average assay crude ore, mostly milled. (Lead wet assay.)

[e] Average assay crude. All to zinc smelters.

Classification of Leadville ores—Continued.

Character.	Recovered contents.					
	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry and siliceous ores[a]	206,717	42,083.06	1,743,317	1,421,252	3,717,076	.....
Copper ores[b]	5,722	2,136.03	144,227	471,437	62,486	.....
Lead ores[c]	43,947	6,593.46	452,206	36,913	10,208,645	.....
Zinc ores[d]	173,374	513.48	128,290	44,710	1,201,622	82,422,971
Copper-lead ores[e]	54	16.81	2,285	4,650	6,757	.....
Lead-zinc ores[f]	73,556	1,635.87	335,104	86,529	10,951,814	23,522,812
Total	503,370	52,978.71	2,805,429	2,065,491	26,148,400	105,945,783

[a] Includes siliceous oxide, largest part of iron-manganese (silver), largest part of iron pyrite. Smelting ores.
[b] Sulphide and oxide. Smelting ores.
[c] Sulphide and oxide lead ores, and that part of iron-manganese ore carrying lead over 4½ per cent. Smelting ores.
[d] Sulphide and carbonate. Greater part to smelters.
[e] Sulphide. Smelting ores.
[f] Sulphide. Greater part to magnetic separating mills.

The course of treatment of Leadville ores, from mine mouth to market, was shown graphically in Mineral Resources for 1911, pt. 1, 1912, p. 547, fig. 1. With the exception of the quantity of ore, the flow sheet for 1911 applies for 1912.

MINES REVIEW.

California Gulch, Iron Hill, Breece Hill mines, as opened by the Yak tunnel.—The main source of the ore supply from the Yak tunnel was again from the property of the Cord Mining Co. (Minnie Lee claim). Besides the operations of the Yak Co., and its auxiliary companies, there were a number of shipments of ore by lessees from other mines controlled and developed by the Yak Co. Other mines from which ore was shipped in 1912 were the Carbonate, Colonel Sellers' Fraction, Comstock (or Hopemore), Dolly B., Favorite, Fortune, Habendum, Resurrection, Rubie, Sedalia, Sierra Nevada, South Cord, Vinnie, Vega, and White Cap. The bulk of the ore was iron sulphide, which was shipped to lead smelters, some going to El Paso, Tex., and some to a sulphuric-acid plant at Kansas City, Mo., the residues being returned to Colorado. The zinc sulphides were sent to the Western Chemical Co., at Denver, to Oklahoma smelters, to Pueblo, and to the United States Zinc & Chemical Co., Argentine, Kans. Several cars of zinc carbonate ore from the White Cap mine went to Oklahoma. A large tonnage of iron concentrates from the closed magnetic separation plant, at the mouth of the Yak tunnel, was sent to smelters. Lead-zinc ore from the dump of the R. A. M. mine was shipped to Denver.

Iron Hill.—The Iron Silver Mining Co., according to its annual report for the year 1912, mined 53,618 tons of crude ore which yielded after sorting 46,410 net tons. * * * The gross value of the shipping ore was $1,848,299. * * * Lessees produced 16,294 tons yielding a net return of $112,705. The following classes of ore were shipped: Zinc-lead, zinc, lead, iron, copper, sulphide, and lead, zinc, iron, oxide.

Lead-zinc ore was shipped from the A. Y. & Minnie mine to Coffeyville, Kans. The Empire Zinc Co. and the U. S. Zinc Co., the pur-

chasers of the A. Y. & Minnie tailings dump, completed the removal of this dump to Canon City and Pueblo, where it was separated magnetically. Iron, lead, zinc, and lead-zinc ores were shipped from the Colonel Sellers Traction mine. Lead, lead-zinc, zinc, and iron sulphide ores were shipped from the Louisville mine. Lead oxide and iron sulphide ores were shipped from the Adelaide, on North Iron Hill, siliceous oxide ore from the Benton mine, siliceous oxide and zinc carbonate from the Mikado mine, and lead sulphide and zinc carbonate from the Smuggler mine.

Breece Hill.—Breece Hill and South Evans Gulch embrace the chief mines of the gold belt.

Lessees on the property of the Ibex Mining Co. continue to ship iron pyrite, copper and lead oxide, lead sulphide, some zinc sulphide, and zinc carbonate ores, as well as considerable metallic gold. Copper-iron sulphide was shipped from the Garbutt and from the Maud Hicks and St. Crispen mines, adjoining. A large tonnage of hematite fluxing ore and siliceous ore was shipped from the Breece-Iron mine. Siliceous oxide from the Big Four, Big Six, and Humboldt; zinc carbonate from the Fanny Rawlings, Highland Chief, and Rattling Jack; and siliceous oxide and lead oxide from the Robert Burns and Nevada mines, were shipped to smelters.

Ball Mountain.—A small tonnage of lead sulphide ore was shipped from the Sunday and Bald Mountain mines, on the western lower part of Ball Mountain, north of Breece Hill.

South Evans Gulch—Little Ellen Hill.—The ores of this vicinity carry appreciable gold and silver content. The New Monarch Mining Co. shipped a decreased tonnage of sulphide and oxide siliceous ores, and also shipped some lead-zinc sulphide derived from a flat ore body in the upper levels to the Western Chemical Co. The lead content of the siliceous ore from this mine decreased considerably. A heavily increased tonnage of oxide and sulphide ores, carrying appreciable gold and silver content, were shipped from the Silver Spoon mine. Similar ores were shipped from the Valley mine. Lead oxide was shipped from the Little Ellen mine.

Stray Horse Gulch.—Siliceous gold-silver ore was shipped from the Double Decker and Fairplay mines.

Carbonate Hill.—The bulk of the output of zinc carbonate at Leadville came from mines on Carbonate Hill. Large tonnages were shipped from the Big Chief mine and from the Maid of Erin and other mines of the Western Mining Co., through the Wolftone shaft, and from the Star Consolidated mines. Iron-manganese-silver ore and lead oxide was also shipped from the Star mines. Iron-manganese ore was also shipped from the Agassiz, Castleview, Evalyn, and Modoc mines. Lead and lead-zinc sulphide were shipped from the Gone-abroad and Arabi Boy mines, and zinc sulphide from the Greenback mine.

Fryer Hill.—Iron-manganese ore was shipped from the Amie, Dunkin, Matchless, R. E. Lee, Shamrock, and Small Hopes mines, and siliceous oxide ore from the Little Sliver mine. Zinc carbonate and iron-manganese ores were shipped from the Chrysolite mine, and iron-manganese, lead oxide, and zinc carbonate ores were shipped from the Little Chief mines. Lead oxide, iron-manganese oxide, and zinc carbonate were shipped from the Blonger, Bullion, Gambetta, Pons Sardine, and Seneca group.

Printer Boy Hill.—Siliceous oxide, lead oxide, and zinc carbonate ores, and some metallic gold were shipped from the Lilian mine, and siliceous oxide ore from the Lovejoy mine.

Rock Hill.—Iron-manganese oxide (carrying lead over 4½ per cent) and zinc carbonate ores were shipped from the La Plata mines, on Rock Hill, east of Iron Hill, across California Gulch.

Iowa Gulch.—Lead sulphide ore was shipped from the Helena and from the Clear Grit mines, and siliceous oxide from the Alleghany mine.

St. Kevin-Independence (or Sugar Loaf) district.—Along the base of the Sawatch Range, including St. Kevin and Sugar Loaf Mountain, is a mineralized region, from which there was shipped an increased tonnage in 1912. Lead-silver ore was shipped from the Carleton-Griffin mine, and a large tonnage of siliceous sulphide ore carrying silver, lead, and gold was shipped from the Dinero mine. A car of silver ore was shipped from the Fanchon mine and an appreciable quantity of silver ore, both oxide and sulphide, was shipped by the Sugar Loaf Consolidated Mining Co.

Twin Lakes district.—Dump ore from the Belle of Granite mine was milled in the old 25-stamp mill on the property. Experimental operations in testing the new amalgamation-concentration mill of the Miller Mining & Tunnel Co., in Lackawana Gulch, resulted in the marketing of gold bullion. A small shipment of gold ore was made from the Mount Champion mine, in the same district.

Big English Gulch.—A shipment of gold ore was made from the Little Crescent mine.

LA PLATA COUNTY.

Production of gold, silver, copper, and lead in La Plata County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*		
1904	12	3,792	$109,151	31,570	2,374	30	$127,526	$33.63
1905	4	5,662	251,940	93,258	2,923	.....	308,724	54.53
1906	8	7,757	303,930	121,711	445	2,228	385,689	49.72
1907	7	7,789	412,499	217,432	.....	340	556,022	71.39
1908	9	2,408	101,300	71,487	.....	.....	139,188	57.80
1909	10	4,135	127,119	74,152	484	2,980	165,869	40.11
1910	8	6,350	390,844	141,537	142	273	467,304	73.59
1911	19	10,058	286,937	69,438	73,728	1,511	333,023	33.11
1912	23	2,761	135,391	47,948	918	6,756	165,334	59.88
Increase (+) or decrease (−)	+4	−7,297	−151,546	−21,490	−72,810	+5,245	−167,689	+26.77

La Plata County in 1912 produced 2,761 tons of ore, yielding $135,391 in gold; 49,948 ounces of silver, valued at $29,488; 918 pounds of copper, valued at $151; and 6,756 pounds of lead, valued at $304, a total value of $165,334, or one-half the value of the yield in 1911. With the exception of the output of some bullion from high-grade specimens, all the ore in 1912 was shipped to smelters, whereas in 1911, 10,058 tons, or one-third of the ore, was milled. The average value per ton in 1912 was $49.04 in gold and $10.68 in silver, as compared with $28.53 in gold and $3.66 in silver in 1911.

La Plata (California) district.—Most of the mines are situated on the west slope of the La Plata Mountains, in the drainage basin of La Plata River, near the town of La Plata, 10 miles from Hesperus, the shipping point on the Rio Grande Southern Railroad. The ores are in general of two kinds, telluride ores and gold, either free or associated with pyrite.

The May Day, Idaho, Incas group, Bessie G., and Lucky Moon were the principal producing mines in 1912. Some of the other producing mines were the Columbus, Comstock, Copper Hill, Golden Eagle, Good Luck, Oro Fino (or Neglected), Portland, Red Rock, Tenbroeck, Verna, and Volcanic.

On the west slope of the west ridge of the La Plata Mountains, in the same district, but in Montezuma County, is the property of the Doyle Consolidated Mines, on which property in 1911 was built a 10-stamp, 50-ton roaster-cyanide plant. The plant was not operated in 1912.

LARIMER COUNTY.

Prospecting and some development work was reported from the Manhattan district, about 45 miles northwest of Fort Collins.

MESA AND MONTROSE COUNTIES.

A car of copper ore was shipped from the Missouri Girl mine, in Mesa County. An appreciable quantity of placer gold was recovered by sluicing on the bench gravels of Dolores River, near Uranium, Montrose County. No work was done on the copper prospects in Unaweep and Sinbad Valley districts. The ores of this region occur as impregnations of the lighter-colored sandstones immediately overlying the "Red Beds."

MINERAL COUNTY.

Production of gold, silver, copper, lead, and zinc in Mineral County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Lbs.*	*Pounds.*	*Pounds.*		
1904	10	124,278	$225,487	1,666,309	.....	9,304,854	2,480,178	$1,710,545	$13.75
1905	10	91,338	182,162	814,189	.....	10,576,146	2,513,457	1,319,305	14.44
1906	13	126,164	159,445	1,150,318	.....	13,038,333	3,562,737	1,890,670	14.99
1907	10	104,977	117,946	870,456	.....	10,656,962	1,838,136	1,365,716	13.01
1908	7	61,131	119,063	725,602	.....	1,731,987	1,100,107	628,080	10.27
1909	7	64,941	108,825	891,185	17,401	9,036,816	1,817,296	1,061,220	16.34
1910	9	62,956	121,181	773,722	29,031	8,246,000	2,421,926	1,036,286	16.46
1911	9	65,932	179,196	545,319	33,384	7,674,556	1,258,561	889,481	13.49
1912	10	66,488	86,002	714,909	23,885	5,730,222	308,681	808,771	12.16
Increase (+) or decrease (−)	+1	+556	−93,194	+169,590	−9,499	−1,944,334	−949,880	−80,710	−1.33

Creede district.[1]—All the producing mines of Mineral County are included in the Creede district except a mine situated 10 miles northwest of Creede, which produced in 1912 for the first time. The output for 1912 was valued at $808,771, of which $86,002 was for

[1] Emmons, W. H., and Larsen, E. S., A preliminary report on the geology and ore deposits of Creede Colo.: Bull. U. S. Geol. Survey No. 530, 1913, pp. 42–65.

gold, $439,669 for silver, $3,941 for copper, $257,860 for lead, and $21,299 for zinc. All the metals, except silver, decreased in output.

Of the 66,488 tons of ore sold or treated in 1912 there were 36,520 tons sent to mills for concentration only, and 29,968 tons were shipped crude to smelters. The average value per ton of all the ore mined in terms of gross values of recovered metals was $12.16 in 1912, as against $13.49 in 1911. The ore sent to smelters averaged: Gold, 0.03 fine ounce, and silver, 22.61 ounces per ton; lead, 2.29 per cent. The assay content of zinc concentrate as shipped was 33.13 per cent.

The producing mines were the Alpha, Amethyst, Bachelor, Commodore, Corsair, Creede United, the Last Chance-New York-Volunteer group, Mollie S., and Ridge. The ore from the Amethyst, Creede United, and Ridge was milled, the product being lead and lead-zinc concentrates. The ore from the other mines was shipped crude to smelters.

The Equity Mining & Investment Co. shipped in 1912 for the first time a considerable quantity of silver-gold ore from its mine, 10 miles northwest of Creede.

MOFFAT COUNTY.

Douglas Mountain district.—Several cars of copper ore were shipped from the Bromide mine, west of Maybell, to Omaha.

Fourmile district (near Baggs, Wyo.).—Sluicing and hydraulicking of the bench and river gravels along Fourmile Creek recovered $4,432 in gold and 10 ounces of silver. Producing mines were the Nelson Bar, Pole Star, and Timberlake.

MONTEZUMA COUNTY.

The mines in Montezuma County are situated at the head of East Mancos River, on the west slope of the west ridge of the La Plata Mountains, this ridge being the arbitrary dividing line between La Plata and Montezuma counties. This district is part of the California or La Plata district of La Plata County.

OURAY COUNTY.

The total value of the output from Ouray County in 1912 was $1,595,178, of which $1,049,590 was for gold, $335,284 for silver, $66,091 for copper, $134,507 for lead, and $9,706 for zinc. This county in 1911 ranked third in the production of gold and fourth in value of total metallic production, but in 1912, with a decrease of $903,368 in gold, it dropped to fourth in production of gold, and to fifth place in total value of output. The output of silver increased in 1912, but the yield of copper and lead decreased. An appreciable quantity of zinc was produced in 1912, as against none in 1911.

The tonnage of ore sold or treated decreased from 133,252 tons to 89,975 tons. The average value per ton in gold was $11.67, as against $14.66 in 1911, against $19.74 in 1910, against $29.32 in 1909, and $21,02 in 1908.

In 1912, of the 89,975 tons mined, 56,593 tons were treated at amalgamating and cyaniding mills having concentration equipment, and an average of $8.39 in gold and 0.18 ounce of silver per ton were

recovered as bullion. From this ore sent to amalgamtion and cyanide mills, and from 30,051 tons sent to mills for concentration only, were produced 16,234 tons of concentrates, averaging $33.95 in gold and 21.22 ounces silver per ton, and also copper, lead, and zinc, with a total average gross value of $58.21 per ton. Those concentrates which carried lead averaged 13 per cent of lead, zinc and lead-zinc concentrates averaged 38 per cent zinc. Crude ore shipped to smelters averaged $7.13 in gold and 57.14 ounces silver per ton, 0.7 per cent copper and 6.89 per cent lead, with a total average gross value of $50.79.

Production of gold, silver, copper, lead, and zinc in Ouray County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	12	91,244	$2,174,361	264,385	431,048	1,771,523	5,016	$2,457,358	$26.92
1905	14	98,966	2,333,282	306,406	52,333	2,491,808	48,267	2,646,478	27.74
1906	23	48,468	992,179	916,256	297,741	5,025,385	10,377	1,950,615	40.25
1907	25	96,662	2,415,049	352,519	410,720	3,496,958	30,407	2,916,989	30.18
1908	21	96,493	2,028,698	415,070	1,019,574	1,675,411	.....	2,453,636	25.43
1909	30	103,864	3,044,825	345,815	984,269	2,813,932	19,148	3,474,637	33.45
1910	24	111,245	2,195,847	414,250	620,236	4,004,728	.....	2,674,520	24.04
1911	31	133,252	1,952,958	512,800	564,273	3,949,822	.....	2,473,018	18.56
1912	35	89,975	1,049,590	545,177	400,552	2,989,044	140,667	1,595,178	17.73
Increase (+) or decrease (−)	+4	−43,277	−903,368	+32,377	−163,721	−960,778	+140,667	−877,840	−.83

Red Mountain district.—This district in 1912 produced 11,908 tons of ore, yielding $131,919 in gold, 43,953 ounces of silver, 35,316 pounds of copper, 291,133 pounds of lead, and 53,729 pounds of zinc, with a total value of $181,585, as compared with $93,733 in 1911. An increased tonnage of ore from the Barstow mines was sent to the company's concentration mill. Iron-zinc-lead concentrates from this mill were re-treated [1] at the custom electrostatic plant at Ouray. Ore was shipped from the Jumbo, San Antonio, Saratoga, and Yankee Girl mines.

Sneffels district.—This is the principal district in Ouray County. In 1912, from 4 mines, there were sold or treated 55,046 tons of ore, from which were recovered $713,252 in gold, 366,153 ounces of silver, 303,618 pounds of copper, 2,505,555 pounds of lead, and 41,676 pounds of zinc, with a total value of $1,104,159, as against $2,162,198 in 1911, a decrease for 1912 of $1,058,039. The quantity of ore treated was one-half that of 1911, and the gold production decreased $1,069,034.

This heavy decrease is due almost entirely to the decreased output of the Camp Bird mine, although the output from the Revenue mine also decreased heavily. The Camp Bird report for the 14 months ended June 30, 1912, shows that there were 66,505 tons of dry ore treated, on which the extraction was 94.68 per cent, yielding $26.15

[1] Wilfley, C. R., Electrostatic separation of Barstow concentrate: Eng. and Min. Jour., Aug. 9, 1913, pp. 249–250.

per ton. The costs, exclusive of depreciation, were $7.81 per ton. In addition, $0.98 per ton was expended in 2,920 feet of development. Of the 60 stamps, 30 were run from January to April 29, and 20 stamps to June 30.[1]

From February 1, 1912, to June 30, 1912, the mill crushed 13,426 tons.[2]

An increased tonnage was treated at the Atlas mill. Crude ore to smelters was shipped from the Torpedo-Eclipse group.

Uncompahgre district.—The Uncompahgre district, from 26 mines, in 1912 produced 23,021 tons of ore, yielding $204,419 in gold, 135,071 ounces of silver, 61,618 pounds of copper, 192,356 pounds of lead, and 45,262 pounds of zinc, with a total value of $309,434, as compared with $187,802 in 1911. The greater part of the ore was sent to amalgamation-concentration mills, the rest being sent to mills for concentration only or to smelters.

The greater part of the ore from the American Nettie mine was amalgamated, the remainder, a copper-lead ore, being sent to smelters. Dry and lead ores were shipped from the Bachelor, Black Girl, El Mahdi, Mineral Farm, and Wedge mines. Ore from the Mickey Breen mine was concentrated into lead, lead-zinc, and zinc concentrates. The Bright Diamond-Ironclad-Memphis group, operated by the Wanakah Co., was the principal producing property. Most of the ore from this property was sent to the company's amalgamation-concentration mill, the bulk of the metal contents being recovered in the concentrates. Ore from the O. & N. mine was amalgamated and concentrated. Production was also made from the Angel, Cascade, Indiana, Jonathan, Morning Star, Newsboy, Portland, and Senorita mines.

PARK COUNTY.[3]

Production of gold, silver, copper, lead, and zinc in Park County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	12	4,202	$191,324	57,064	.....	156,270	69,000	$234,281	$55.76
1905	19	6,745	320,867	49,202	12,199	543,303	.....	378,023	55.63
1906	16	10,072	395,050	144,815	14,399	966,193	.....	549,928	53.59
1907	24	12,661	513,216	111,215	.....	1,062,732	333,407	662,614	51.78
1908	20	11,372	430,808	12,047	37,106	495,985	728,000	497,138	42.65
1909	16	15,046	551,921	102,375	61,023	2,237,093	366,574	729,079	46.83
1910	17	12,329	265,547	117,037	88,748	2,041,204	659,796	465,460	36.71
1911	25	5,780	58,832	69,072	24,216	923,089	407,772	163,249	24.02
1912	27	2,686	67,981	31,234	10,321	167,756	132,275	105,569	32.10
Increase (+) or decrease (−)	+2	−3,094	+9,149	−37,838	−13,895	−755,333.	−275,497	−57,680	+8.08

[a] Includes placer production.

The value of the metallic output of Park County in 1912 was $105,569, of which $67,981 was for gold, $19,209 for silver, $1,703 for copper, $7,549 for lead, and $9,127 for zinc. There were 20 producing deep mines and 7 placers in 1912, as against 22 deep and 3 placer

[1] Eng. and Min. Jour., Nov. 23, 1912, p. 973.
[2] Eng. and Min. Jour., Aug. 24, 1913, p. 374.
[3] Patton, Horace B., Hoskin, Arthur J., Butler, G. Montague, Geology and ore deposits of the Alma district, Park County, Colo.: Bull. Colorado State Geol. Survey No. 3, 1912.

mines in 1911. The placer yield was $19,223 in gold and 189 ounces of silver in 1912, as against $24,411 in gold and 49 ounces of silver in 1911.

Beaver district.—The Rhodus placer was idle in 1912.

Buckskin district.—The Buckskin district in 1912 produced 484 tons, which yielded $3,215 in gold, 1,750 ounces of silver, 313 pounds of copper, 12,931 pounds of lead, and 32,756 pounds of zinc, with a total value of $7,185, as against $2,591 in 1911. In addition to several shipments to smelters, the output from the Paris mine included bullion from the amalgamating mill on the property. Lead-zinc ore was shipped from the Sampson mine, and shipments of dry ore were made from the Weber group and Wyandotte mines.

Consolidated Montgomery district.—All the ore from this district was shipped to smelters. From 271 tons, the yield was $1,441 in gold, 5,442 ounces of silver, 1,515 pounds of copper, 4,576 pounds of lead, with a total value of $5,244, as against $11,754 in 1911. Producing mines were the Baltic, Dolly Varden, Lucky Queen, Manhattan, Moose, Morning Star, Pacific, and Sweet Home mines.

Freshwater district (Guffey).—No output was made from this district in 1912.

Hall's district.—No output was made from this district.

Horseshoe district.—The output from the Chance-Hilltop mine decreased considerably. The Platte River Placer Co., operating the Snowstorm placers, made a small yield.

Mosquito district.—The Mosquito district, for many years the principal district in Park County, made an increased output in 1912, as compared with the yield in 1911. The 1912 production was valued at $49,843 of which $42,401 was for gold. This production was still much below the yields of 1910 and 1909.

An increased quantity of ore was shipped from the London [1] mine, at the head of Mosquito Creek, on the ridge between Leadville and Alma. The ore from this mine is lead, carrying a high content of gold, as well as some silver and copper. Shipments were also made from the Champaign, Golden Wave, Hock Hocking, and Kennebec mines.

Tarryall district.—A shipment of ore was made from the Reliance mine. There was a small yield of placer gold from sluicing operations in the district.

PITKIN COUNTY.

Production of gold, silver, copper, lead, and zinc in Pitkin County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	36	109,770	$971	2,150,035	2,908	9,071,761	44,375	$1,631,338	$14.89
1905	25	107,927	248	2,469,520	41,276	22,386,142	5,268,091	2,861,243	26.51
1906	27	203,400	1,172	2,131,374	.....	17,951,674	3,673,755	2,676,537	13.11
1907	20	183,836	579	1,719,446	10,735	12,235,230	5,799,746	2,128,212	11.58
1908	18	133,408	538	1,041,700	.....	7,568,060	722,362	904,449	6.78
1909	12	112,448	745	700,038	26,092	13,143,210	34,741	935,191	8.32
1910	12	89,037	646	477,813	24,843	13,408,250	.....	851,783	9.57
1911	11	88,823	542	450,772	7,408	11,084,334	.....	739,172	8.32
1912	9	91,791	165	528,504	22,952	8,405,333	484,507	740,653	8.07
Increase (+) or decrease (−)	−2	+2,968	−377	+77,732	+15,544	−2,679,001	+484,507	+1,481	−.25

[1] Moore, Charles J., The London mine, Mosquito mining district, Colo.: Bull.; Trans. Am. Inst. Min. Eng. No. 75, March, 1913, pp. 415–427.

Pitkin County in 1912 produced 91,791 tons of ore, with a total value of the content for all five metals of $740,653, of which $165 was for gold, $325,030 for silver, $3,787 for copper, $378,240 for lead, and $33,431 for zinc. The silver yield increased but the lead output decreased. Zinc was again produced, after a lapse of two years. Both zinc sulphide and zinc carbonate ores were shipped. The tonnage of ore milled in Pitkin County decreased, but there were increased shipments of crude ore to smelters. The average content of all the ore sold or treated was 5.76 ounces of silver and 4.58 per cent of lead.

Pitkin County fell from fifth to sixth place in the yield of silver, and from second place after Lake to third place after San Juan in the yield of lead.

Roaring Fork (Aspen) district.—The Aspen district has always furnished the bulk of the ore from Pitkin County, and in 1912 there was no output from other districts. The Smuggler mine was the principal producing mine, with an increased tonnage of smelting ore and a decreased tonnage of milling ore. Smelting ore was shipped from the Argentum-Juniata, Aspen, Durant, Last Dollar, Millinee mines, and from the Varney tunnel.

Ashcroft (or Columbia) district.—The Tam O'Shanter-Montezuma mine was idle in 1912.

RIO GRANDE COUNTY.

Summitville district.[1]—Gold-copper ore was shipped from the Golconda mine.

ROUTT COUNTY.

Hahns Peak district.—Sluicing operations on the Leckenby-Blackburn placer produced an appreciable quantity of gold.

Considerable development work was done on the property of the Farewell Mountain Copper Co. Continuous development work was done on the Royal Flush mine, and a 400-ton concentrating mill is in prospect.

Slater district.—Assessment work was done on the mines near Slater.

SAGUACHE COUNTY.

Production of gold, silver, copper, lead, and zinc in Saguache County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	5	499	$8,641	47,233	48,066	18,000	18,000	$43,380	$86.98
1905	4	496	699	4,401	1,135	203,797	.....	13,112	26.44
1906	7	999	7,628	737	.....	49,141	.....	10,923	10.93
1907	4	170	649	6,194	1,260	22,528	.....	6,183	36.37
1908	5	76	610	953	76	27,715	.....	2,289	30.12
1909	8	192	1,196	2,260	3,769	83,463	.....	6,450	33.59
1910	8	296	1,025	4,841	5,362	161,068	.....	11,407	38.54
1911	8	184	512	4,664	4,984	74,556	46,561	9,616	52.26
1912	12	9,459	3,805	19,309	29,479	504,845	534,928	80,172	8.48
Increase (+) or decrease (−)	+4	+9,275	+3,293	+14,645	+24,495	+430,289	+488,367	+70,556	−43.78

[1] See Conejos County.

Saguache County in 1912 produced 9,459 tons of ore, yielding $3,805 in gold; 19,309 ounces of silver, valued at $11,875; 29,479 pounds of copper, valued at $4,864; 504,845 pounds of lead, valued at $22,718; and 534,928 pounds of zinc, valued at $36,910; with a total value of $80,172, as compared with $9,616 in 1911.

Baca Grant (Crestone) district.—Small lots of ore were shipped from the Pelican and Sultan mines.

Cochetopa district.—Zinc sulphide ore was shipped from the Alaska mine.

Embargo district.—A small shipment of lead ore was made from the Comet mine.

Kerber Creek (Bonanza) district.—This was the principal producing district in Saguache County in 1912. From the Antoro mine, lead-zinc ore was concentrated into lead and lead-zinc concentrates at the Kortright mill, and lead ore was shipped to smelters. Lead ore and lead concentrates were the products from operations on the Erie and Superior mine. A large tonnage of lead-zinc ore from the Bonanza mine was concentrated into lead and lead-zinc concentrates. Copper-lead ore from the Elizabeth, lead ore from the Jupiter and from the Empress Josephine, and dry ore from the Horrigan-Page mine, were shipped to smelters. An adit, 6,235 feet long, which the Rawley Mining Co. has been driving[1] continuously for several years, was completed in 1912 and some ore was placed on the dump. There is an 100-ton concentrating plant on this property.

SAN JUAN COUNTY.

Production of gold, silver, copper, lead, and zinc in San Juan County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	31	233,663	$1,736,229	1,584,938	3,575,219	10,303,414	1,384,340	$3,610,509	$15.45
1905	20	204,139	1,050,971	750,844	1,675,858	8,045,126	248,627	2,158,705	10.57
1906	26	196,438	900,175	690,076	1,549,663	4,515,317	584,476	1,954,637	9.94
1907	27	235,639	967,732	1,175,176	2,450,280	12,483,507	237,677	2,909,053	12.35
1908	42	202,643	997,824	1,004,287	2,282,738	8,402,569	10,131	2,184,801	10.78
1909	40	187,041	683,267	793,637	1,653,192	9,085,068	786,518	1,744,003	9.32
1910	54	206,272	[a] 710,257	[a] 782,250	1,208,496	10,688,386	3,781,259	1,960,898	9.50
1911	38	108,088	[a] 336,463	[a] 325,604	470,912	6,933,822	2,224,351	1,006,707	9.31
1912	41	140,917	523,574	714,974	1,063,291	9,114,334	2,478,594	1,719,894	12.21
Increase (+)...	+3	+32,829	+187,111	+389,370	+592,379	+2,180,512	+254,243	+713,187	+2.90

[a] Includes placer production.

San Juan County in 1912 produced 140,917 tons of ore, with a gross value for all five metals of $1,719,894, of which $523,574 was for gold; $439,709 for silver; $175,443 for copper; $410,145 for lead; and $171,023 for zinc.

During 1912 there were treated at amalgamation and cyanide mills 44,774 tons of ore, with an average recovery per ton in bullion of $2.16 in gold and 0.04 ounce silver; there were also 89,522 tons sent to

[1] Simonds, F. M., and Burns, E. Z., A problem in mining, together with some data on tunnel driving: Bull. Trans. Am. Inst. Min. Eng. No. 75, March, 1913, pp. 369–402.

mills for concentration only, a total of 134,296 tons (95.3 per cent of all the ore mined) yielding 20,693 tons of concentrates averaging $17.39 per ton in gold, 14 ounces of silver, and also copper, lead, and zinc, with a total gross value per ton of $55.85. Crude ore shipped to smelters—6,621 tons—averaged per ton $10.18 in gold, 64 ounces of silver, and $21.13 for copper, lead, and zinc, a total of $70.67, as compared with $55.67 in 1911.

Animas district (including the mines in the immediate vicinity of Silverton, and south and east of Animas River from Silverton to Middleton).—This district in 1912 produced 58,176 tons of ore, yielding $114,567 in gold, 530,753 ounces of silver, 591,992 pounds of copper, 4,280,176 pounds of lead, and 126,053 pounds of zinc, with a total value of $739,965, as against $394,230 in 1911.

There were 26 producing mines in the Animas district, as compared with 25 in 1911. The principal producing mine in 1912 was again the Iowa-Gold Tiger group, with an output entirely in lead concentrates. The second largest output was from the Silver Lake mines, the bulk of the ore also being concentrated into lead concentrates. Ore from the Intersection mine was treated by amalgamation and concentration, and ore from the Old Green Mountain mine was concentrated. Ore from the Aspen mine was concentrated or shipped to smelters. Lead ore from the Dives, and copper-lead ores from the Highland Mary mine, were shipped to smelters. Small shipments were made from the Alice, Bonner, Brooklyn, Buffalo Boy, Champion, Kansas City, Kittimac, North Star, Pokeepsie, Potomac, Queen City, Shenandoah, and other mines.

Eureka district (north of Silverton, including Chattanooga, Gladstone, Animas Forks, Eureka).—This district in 1912 produced 82,585 short tons of ore, yielding $388,166 in gold, 179,368 ounces of silver, 469,540 pounds of copper, 4,806,639 pounds of lead, and 2,352,541 pounds of zinc, with a total value of $954,575, as compared with $612,245 in 1911.

There were 15 producing mines in 1912, as against 12 in 1911. Nearly all the ore of this district was milled. The largest tonnage in the district was mined at the Sunnyside mine, and milled at the Sunnyside mill, where over one-half of the recovered gold and a small quantity of silver were recovered on the amalgamating plates, the remainder of the product being lead and lead-zinc concentrates and iron-zinc middlings. In 1912, the Huff electrostatic separating machine was installed for separating the iron from the zinc in the zinc middlings.[1] A large and increased output was mined from the Gold King mine, by lessees. The bulk of this ore was concentrated and a small part sent to smelters. Lead and zinc concentrates were the product from the concentration of ore from the Silver Ledge mine, at Chattanooga. Lead-zinc ore and lead-zinc concentrates were marketed from the Vermilion mine. Copper-lead ore was shipped from the Congress mine. Other producing mines were the Esmeralda, Bagley tunnel, Joe and John, San Juan Queen, Scotia, and Silver Doctor.

[1] For description, see Eng. and Min. Jour., July 20, 1912, p. 105.

SAN MIGUEL COUNTY.[1]

Production of gold, silver, copper, lead, and zinc in San Miguel County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	25	231,316	$1,728,838	1,329,184	245,709	6,184,375	.....	$2,791,077	$11.77
1905	19	291,338	1,711,853	1,275,079	17,721	6,970,152	.....	2,812,362	9.58
1906	21	386,735	2,447,790	1,672,522	70,725	7,158,189	.....	3,990,047	10.31
1907	29	407,491	2,467,516	1,438,299	14,905	5,274,641	.....	3,699,330	9.08
1908	26	428,231	2,317,651	1,543,187	382,402	5,555,049	952,872	3,464,114	8.08
1909	40	423,609	2,285,051	1,344,152	501,285	4,941,370	804,296	3,305,088	7.80
1910	43	481,000	2,494,793	1,144,050	544,189	7,791,841	2,193,981	3,643,008	7.57
1911	28	429,354	2,447,841	1,000,834	971,064	6,456,333	3,386,088	3,583,208	8.35
1912	26	455,692	2,399,234	1,153,709	845,497	7,429,622	2,943,783	3,785,726	8.31
Increase (+) or decrease (—).	—2	+26,338	—48,607	+152,875	—125,567	+973,289	—442,305	+202,518	—.04

[a] Includes placer production.

The value of the metallic production of San Miguel County in 1912 was $3,785,726, of which $2,399,234 was for gold, $709,531 for silver, $139,507 for copper, $334,333 for lead, and $203,121 for zinc. All the districts showed an increase in total value of output.

In point of tonnage mined in 1912, San Miguel County stood third after Teller and Lake. In gold yield, San Miguel maintained its place as second to Teller, and in silver, held second place after Lake County. In total gross value of metals produced, San Miguel stood third, with Lake first, Teller second, and San Juan fourth.

During 1912 there were treated at amalgamation and cyanide mills 418,886 short tons of ore, or 92 per cent of all the ore mined; and an average of $3.58 in gold and 0.73 ounce of silver per ton was saved as bullion. The gold saved as bullion in 1912 represented 63 per cent of the gold produced in the county, and the silver in bullion represented 26 per cent of the county silver output.

There were 35,600 tons of ore sent to mills for concentration only, a total of 454,486 tons milled (99.7 per cent of all the ore mined), which yielded 31,154 tons of concentrates, averaging $28.65 in gold, $16.43 in silver, and $20.79 in copper, lead, and zinc, a total per ton of $65.87, as compared with $55.51 in 1911.

Crude ore to smelters—1,210 tons—averaged $5.18 in gold and 58.3 ounces silver per ton, and 0.5 per cent copper and 24.8 per cent lead, with a total value per ton of $65.17, as compared with $64.49 in 1911.

Upper San Miguel district.—The Upper San Miguel district in 1912 produced 403,806 tons of ore, yielding $2,275,883 in gold, 987,204 ounces of silver, 786,829 pounds of copper, 6,255,953 pounds of lead, and 2,943,783 pounds of zinc, with a total value of $3,497,479, as compared with $3,323,133 in 1911. Three large companies, the Liberty Bell, the Smuggler Union, and the Tomboy, furnished more than 90 per cent of the total output.

[1] Hess, F. L., Notes on the vanadium deposits near Placerville, Colo.: Bull. U. S. Geol. Survey No. 530, 1912, pp. 142–156.

The yield from the Argentine-Montana mine of the Tomboy Gold Mines Co. (Ltd.) was larger than in 1911, with increased metal content of all the metals except zinc. The annual report for the year ending June 30, 1912, states:

> That 107,577 tons of ore were milled, of which 21,702 tons came from the Montana and the remainder from the Argentine mine. The recovery of metals was worth $954,981, the cost of mining, treatment, etc., was $504,040, and the profit $450,941. An increasing proportion of the precious metals is now being recovered in concentrates, of which several are produced, varying in lead, zinc, and iron content. The new concentration plant has been erected * * *. The 21,702 tons (from the Montana) sent to the mill averaged $10.50 in gold and silver * * *. The reserve at the Argentine group is 340,000 tons, that at the Montana 150,000 tons.[1]

The Liberty Bell mine and mill[2] were actively operated. Early in 1913 this company installed a plant for cyanidation of concentrates by fine grinding and agitation by Dorr continuous decantation wash.

The Smuggler Union mines and amalgamation, concentration, and cyanide mills were steadily operated. One of the mills (the 60-stamp) was remodeled and a slimes plant added to the cyanide plant.[3]

Lead ore from the Lewis mine was concentrated. Ore from the Cimarron mine was treated by amalgamation and concentration. Ore from the Wasatch-Orion group of the Junta Co. was treated in a small amalgamation-concentration mill, but a new 300-ton cyanidation plant is in prospect. A small tonnage from the Ballard mine was treated at the Junta mill. Ore from the Nellie mine was treated by amalgamation and concentration.

Iron Springs (Ames and Ophir) district.—The Iron Springs district in 1912 produced 51,763 tons of ore, yielding $122,154 in gold, 166,006 ounces of silver, 58,362 pounds of copper, 1,157,455 pounds of lead, with a total value of $285,963, as compared with $259,190 in 1911.

There were 11 producing mines in the district, as against 9 in 1911. An increased output from the Alta mines was treated by concentration, the product being lead concentrates, carrying appreciable quantities of gold and silver and some copper. Lead ore continued to be shipped from the Carbonero group. The yield in bullion and concentrates from the Butterfly-Terrible mines and amalgamation-concentration mill showed little change.[4] The Favorite mine was operated for several months, the ore being sent to a custom amalgamation-concentration mill. Development work was continued on the Lake Superior-Ophir group and a considerable quantity of ore was milled. The Suffolk[5] amalgamation-concentration mill was remodeled to a cyanide mill in 1912 and an increased tonnage treated. Lead ore was shipped from the San Bernardo mine.

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[1] Min. Mag. (London), November, 1912, p. 388. See also Eng. and Min. Jour., Dec. 7, 1912, p. 1088.

[2] Megraw, Herbert A., Cyanidation at the Liberty Bell mill: Eng. and Min. Jour., Jan. 4, 1913, pp. 9–14. Also, Cost of milling at the Liberty Bell: Metall. and Chem. Eng., January, 1913, pp. 49–50.

[3] For brief sketch of changes, see Min. and Sci. Press, Jan. 4, 1913, p. 74.

[4] For report of operations for year ending Mar. 31, 1912, see Eng. and Min. Jour., Sept. 14, 1912, p. 497.

[5] See Parmelee, H. C., Cyaniding slimy ore by continuous decantation: Metall. and Chem. Eng., January, 1913, pp. 25–28. See also Min. Mag. (London), February, 1913, p. 144.

Lower San Miguel (Sawpit and Placerville) district.—A small quantity of gold-silver bullion was marketed from the treatment of ore from the Golden Rose mine, and a small shipment of ore was made from the Lizzie G mine.

Mount Wilson district.—A shipment of lead ore was made from the Morning Star mine.

SUMMIT COUNTY.

Production of gold, silver, copper, lead, and zinc in Summit County, Colo., 1904–1912.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	37	35,475	$202,443	292,149	.....	5,592,140	2,512,778	$739,995	$18.20
1905	34	36,930	157,476	209,356	.....	2,181,660	3,320,237	582,359	14.85
1906	39	34,050	139,773	107,752	27,120	1,301,912	2,942,983	470,932	12.25
1907	39	25,127	106,590	125,847	21,865	1,915,133	3,026,627	474,095	17.37
1908	28	14,631	186,941	66,025	28,523	1,719,190	1,232,149	355,816	14.42
1909	32	31,098	452,766	99,763	3,839	3,559,278	5,798,167	971,292	18.11
1910	29	47,040	368,766	152,250	21,740	5,015,409	5,542,685	973,725	13.27
1911	44	55,904	284,241	182,957	22,888	6,024,867	7,675,175	1,092,673	14.91
1912	39	46,606	426,015	164,665	16,412	4,402,422	9,342,725	1,372,749	20.96
Increase (+) or decrease (−).	−5	−9,298	+141,774	−18,292	−6,476	−1,622,445	+1,667,550	+280,076	+6.05

[a] Includes placer production.

Summit County deep mines in 1912 produced 46,606 short tons of ore, yielding $33,276 in gold; silver, valued at $98,310; copper, at $2,708; lead, at $198,109, and zinc, at $644,648, a total of $977,051, as compared with $833,466 in 1911, an increase for 1912 of $143,585. Dredges and other placer operations yielded $392,739 in gold and 4,812 ounces of silver, valued at $2,959, a total of $395,698, as against $257,422 in gold and 3,368 ounces of silver, a total value of $259,207 in 1911.

Summit County is the foremost placer area in Colorado and in production of zinc ranks second to Lake County.

Breckenridge district.—Breckenridge district includes Bevan, Minnesota, and Union districts; includes the mines near Breckenridge, on French Gulch, and on Blue and Swan rivers; and includes all the placers of the county. The value of the total output of gold, silver, copper, lead, and zinc, from both deep and placer mines, was $1,250,544, or 91 per cent of the county yield, and an increase for 1912 of $385,413, as compared with the yield in 1911.

The principal producing property in this district is the Wellington mines. A large and increased quantity of lead-zinc ore was milled at the company's 100-ton wet concentration mill, lead and zinc concentrates being shipped. In addition, in 1912, a considerable quantity of zinc middlings from former years' operations, as well as from 1912 operations, were treated in the company's new roasting and magnetic separation plant[1] completed early in 1912. Lead

[1] For description of magnetic plant, see Parmelee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., September, 1912, pp. 527–528.

concentrates were the product from the Blue Flag mill. Lead ore was shipped from the Dunkin mine and several cars of zinc ore from the Country Boy mine. Other producing mines were the Arctic, Carbonate, Congress, Germania, Junebug, Lucky, New York, Ohio, Standard, and Tip Top. An appreciable quantity of free gold was marketed from mines on Farncomb Hill.

Although only 3 of the 4 dredges [1] in the district were operated in 1912, there was an increased output. The Reliance dredge, in French Gulch, is of the double-lift, open-connected type, with buckets of a capacity of 9 cubic feet. The French Gulch Dredging Co., or Reiling dredge, is of the Bucyrus type. Only one of the 2 dredges of the Colorado Gold Dredging Co. was operated in 1912, and one of the dredges has been partly dismantled. Both dredges are of the Bucyrus open-connected type, with buckets having a capacity of 9½ cubic feet. All the dredges are operated by electricity. During the dredging season of 1912, according to the annual report of the Colorado Dredging Co.—

> One million two hundred and seventy thousand four hundred and seventy-six cubic yards were dredged, giving a total yield of $208,248, or an average of $0.16391 per cubic yard. The average cost was $0.05296 per cubic yard, and administration and general expenses $0.00263 per cubic yard, a total of $0.05559 per cubic yard, leaving a profit of $0.10832 per cubic yard.[2]

The Washington placer was operated by hydraulicking and the Snyder placer by hydraulicking and drifting. The Jackson and Sisler placers were operated by sluicing. The Buffalo placer, in Salt Lick Gulch, near Dillon, was operated by steam shovels and washing machine.

Consolidated Tenmile district (Frisco, Kokomo, and Robinson).—This district in 1912, from 10 mines, produced 8,398 short tons of ore, yielding $9,224 in gold, 60,679 ounces of silver, 2,052 pounds of copper, 754,176 pounds of lead, and 414,419 pounds of zinc, with a total value of $109,414, as compared with $168,800 in 1911. The International (or Robinson) mine was again the principal producer, but was closed in September, 1912, with the result that a decreased tonnage was sent to the Robinson roasting, magnetic separator, and wet concentration mill.[3] Lead zinc ore to the Western Chemical Manufacturing Co. and lead ore to Leadville were shipped from the Nettie B. mine. Shipments were made from the Eureka-Columbine, Excelsior, Felecia Grace, John B. Jr., Michigan, Queen of the West, Reconstruction, and Roswell Sprague mines.

Montezuma district.[4]—The output mined in this district decreased heavily. Lead ore was shipped from the Bolivar, Pennsylvania, Silver Princess, and Silver Wave mines.

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[1] Lakes, Arthur, jr., Gold-dredging operations in Breckenridge district: Min. and Eng. World, Dec. 2, 1911, pp. 1103–1107.

[2] Eng. and Min. Jour., July 19, 1913, p. 122.

[3] See Parmelee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., February, 1911, pp. 91–95.

[4] See Patton, Horace B., The Montezuma mining district, of Summit County, Colo.: First Report, 1908, Colorado Geol. Survey, 1909, pp. 104–144.

TELLER COUNTY.

Production of the Cripple Creek district, Colorado, 1891–1912.[a]

Year.	Number of producing mines.	Tonnage.[b]	Gold, value.	Silver.		Total value.
				Quantity.	Value.	
		Short tons.		*Fine ozs.*		
1891	.....	.....	$449	.....	.....	$449
1892	.....	.....	583,010	.....	.....	583,010
1893	.....	.....	2,010,367	5,019	$3,915	2,014,282
1894	.....	.....	2,908,702	25,900	16,317	2,925,019
1895	.....	.....	6,879,137	70,448	45,791	6,924,928
1896	.....	.....	7,512,911	60,864	41,387	7,554,298
1897	.....	.....	10,139,709	57,297	34,278	10,174,087
1898	.....	.....	13,507,244	68,195	40,235	13,547,479
1899	.....	.....	15,658,254	82,520	49,512	15,707,766
1900	.....	.....	18,073,539	80,166	49,703	18,123,242
1901	.....	.....	17,261,579	90,884	54,530	17,316,109
1902	.....	.....	16,912,783	62,690	33,226	16,946,009
1903	.....	.....	12,967,338	42,210	22,793	12,990,131
1904	102	597,819	14,456,536	47,817	27,734	14,484,270
1905	88	716,358	15,641,754	56,951	34,740	15,676,494
1906	105	702,069	13,930,526	67,943	46,201	13,976,727
1907	83	451,082	10,370,284	51,630	34,076	10,404,360
1908	96	601,173	13,031,917	52,270	27,703	13,059,620
1909	83	575,670	11,466,227	63,204	32,866	11,499,093
1910	83	688,941	11,002,253	54,263	29,302	11,031,555
1911	92	756,900	10,562,653	57,783	30,625	10,593,278
1912	74	849,172	11,008,362	66,117	40,662	11,049,024
Total	.....	.....	235,885,534	1,164,171	695,696	236,581,230
Increase (+) for 1912 over 1911	−18	+92,272	+445,709	+8,334	+10,037	+455,746

[a] Figures for 1891–1903 from reports of the Director of the Mint; figures 1904–1912 actual recovery by mills and smelting. In 1907 the Portland Co. installed a cyanide plant to treat the accumulated tailings of previous years and to treat tailings from the chlorination barrels. The United States Reduction & Refining Co. has also a cyanide plant auxiliary to the Standard chlorination plant, and old tailings of previous years as well as tailings from day to day from the Standard plant are treated here.

[b] Mine reports.

Cripple Creek district.—In 1912 there was recovered from ore from the Cripple Creek district by mills and smelters from crude ore and dump ore, from the treatment of tailings of previous years, from tailings of operations in 1912, from slags, slimes, and "clean-ups" of mills, and from stolen bullion and ore 532,529.51 fine ounces of gold, valued at $11,008,362, an increase as compared with the yield in 1911 of $445,709.

From the viewpoint of the mines alone, as reported from 74 properties, 842,002 short tons of material from mine ore and mine dumps were sold or treated, which averaged per ton 0.6163 ounce gold, valued at $12.74 (or $12.33 at $20 per ounce), a total content of 518,949.25 fine ounces, valued at $10,727,633 (or $10,378,985 at $20 per ounce). Subtracting the tonnage and contents of the dump ore and low-grade ore treated in 1912—346,683 tons, containing 38,980 fine ounces of gold—the remainder, 495,319 tons, averaged per ton 0.9690 ounce gold (or $19.38 at $20 per ounce). For the year 1908 (not including old tailings treated at Colorado Springs) the tonnage from Cripple Creek mines was 601,173 tons of ore, averaging 0.9922 ounce in gold, and in 1911 (not including old tailings treated at Colorado Springs nor the low-grade ore treated in the district), the tonnage was 472,256 tons, averaging 0.9726 ounce in gold.

During 1912 the shipments of medium-grade ore from Cripple Creek showed a small decrease, but the shipments of the higher-grade ore to smelters showed a small increase, and also an increase in average gold content. There was a heavy increase in low-grade dump and

mine ores sent to cyanide and cyanide-concentration mills in the district, and also an increase in the quantity of gold recovered from old tailings, slimes, and "clean-ups" of closed mills.

THE CRIPPLE CREEK DRAINAGE OR ROOSEVELT TUNNEL.

T. R. Countryman, engineer for the Roosevelt Tunnel, reports (Mar. 3, 1913) that the flow continues at over 8,000 gallons per minute from the tunnel, which is 16,857 feet long. Results at the beginning of the year 1913 were: The El Paso mine was dry; the Elkton shaft was down to 185 feet below the tenth level, and the water was receding about 10 feet per month; the Mary McKinney shaft was down 920 feet; the water in the Portland was lowered 207 feet; the Cresson shaft was down 1,400 feet, as compared with 1,265 at the beginning of the year 1912. The Vindicator and the Golden Cycle mines were not benefited by the drainage, and the two companies have installed electric pumps at the Golden Cycle to raise the water from both properties.

MILLS AT COLORADO CITY.

In 1912 smelters treated only 5 per cent of the ore from Cripple Creek, including slightly over 4 per cent of the crude ore and a small tonnage of concentrates. (The material treated by smelters, however, contained 18 per cent of the gold yield). Local mills and mills at Colorado City treated, therefore, over 95 per cent of the original crude tonnage. In addition, a considerable tonnage of tailings from former operations was treated by the Portland mill at Colorado Springs and the Florence mill at Florence.

The valley mills adjoining Colorado City are the Golden Cycle, a roast-cyanide (with subsidiary amalgamation) plant of 1,200 tons capacity; the Portland, a 350-ton cyanide-concentration mill; and the Standard, a chlorination-concentration plant with cyanide annex. The Portland plant used the chlorination process until the end of the year 1911. The Standard chlorination plant was closed at the end of 1911, but the cyanide annex was operated for a while on old tailings, etc.

At Florence, Fremont County, the tailings of the old Union chlorination mill were treated in the 500-ton cyanide plant, built in 1911 by the United States Reduction & Refining Co.

The total output of these mills in bullion was $8,577,693 in 1912, as compared with $8,534,832 in 1911, with $8,681,077 in 1910, and with $8,902,459 in 1909.

RATES OF TREATMENT CHARGES AT CUSTOM MILLS.

The treatment and freight rates on ore at the beginning of 1913 were as follows,[1] based on payment of $20 per ounce for gold content:

	Freight and treatment per ton.
MILLS:	
Less than ½ ounce	$4.00
One-half to ¾ ounce	5.00
Three-fourths to 1 ounce	6.00
1 to 1¼ ounces	6.25
SMELTER:	
1¼ to 1½ ounces	6.50
1½ to 2 ounces	7.00
2 ounces and more	8.00

[1] Min. and Sci. Press, Feb. 1, 1913 p. 220. See also Mines and Minerals, May, 1911, p. 588; and Min. and Sci. Press, Jan. 6, 1912, p. 78.

MILLS IN THE CRIPPLE CREEK DISTRICT.[1]

The Stratton's Independence mill, at Victor, started in April, 1909, with a capacity of 4,500 tons per month, was enlarged to treat 7,000 tons in December of that year, and in November, 1910, with the addition of the second unit, reached a capacity of 9,000 tons. During 1911 the capacity was brought up to approximately 10,000 tons a month, and 109,800 tons were treated in the year ending June 30, 1911, and 112,391 tons in the year ending June 30, 1912.[2]

The Portland Gold Mining Co.'s new concentration-cyanide plant was completed at Victor in June, 1910. The annual report of the Portland Co. for 1912 says, regarding the Victor mill:

> Its capacity has been increased from 12,285 tons treated in December, 1911, to 14,791 tons treated during the month of December, 1912. We found, while treating the increased tonnage at the beginning of the year, that larger profits could be made by increasing our concentrating department. To this end an additional building was constructed in which 12 concentrating tables were placed. * * * The gross tonnage treated for the year was 173,361, of a gross value of $547,424, upon which a net profit at the mill was made of $203,414. The average value per ton of the ore treated was $3.15, and the average profit per ton was $1.17. * * * The profits earned by the mill for the two years of 1911 and 1912 were 90 per cent of the entire cost of the mill.

Other operating mills in the district (all cyanide) were the Ajax, a 300-ton plant, in which during 1912 a modification of the Clancy process was tried out, with the result that in 1913 the mill was remodeled to the concentration-cyanide process on much the same plan as the Portland and Stratton's Independence mills; the Blue Flag mill, a 50-ton leaching mill which was remodeled to an 150-ton agitation plant; the Dante (Gaylord) leaching mill; the Jo Dandy (Kavanaugh) leaching mill; the Isabella, in which the ore is treated by coarse crushing only, but with longer duration of solution; and the Wild Horse coarse crushing mill.

MINES REVIEW.

An increased quantity of ore was shipped from the Acacia Mining Co.'s property. In addition to the low-grade material treated at the Colburn-Ajax mill, a considerable tonnage of the higher-grade mine ore was shipped to custom mills and smelters from the Ajax mine. Desultory leasing on the Ajax-Uintah mine resulted in a small but increased yield, and a small output was made from the Aloha mine. A small tonnage was shipped from the Kalamazoo mine of the Alert Co. The Anchoria-Leland mine was continuously operated; a decreased tonnage was shipped from the Blue Bird mine. The Blue Flag cyanide mill was changed from a leaching plant to an agitation plant with increased capacity. A decreased tonnage was shipped from the Christmas mine. The Raaler mine of the C. K. & N. Co., drained by the lateral from the drainage tunnel and reopened in 1911, was an important producer. The school section 16 was operated continuously, and lessees shipped ore from the Creede and Cripple Creek Co. mines. An increased tonnage was mined from the Cresson mines. A dry crushing leaching plant was built for treatment of the

[1] For review of Cripple Creek practice, see Argall, P. H., Eng. and Min. Jour., Jan. 11, 1913, pp. 108–110. Also Argall, P. H., Colorado metallurgical progress: Min. and Sci. Press, Jan. 6, 1912, p. 78; and Goodale, Stephen L., Leasing and low-grade milling at Cripple Creek: Min. and Sci. Press, Aug. 23, 1913, pp. 297–300.

[2] For description of process see Mineral Resources, U. S., for 1911, pt. 1, U. S. Geol. Survey, 1912, p. 565, or Min. Mag. (London), December, 1911, and Min. Mag. (London), November, 1911, p. 361–370.

dump ore of the Dante mine. An increased output was shipped from the Dexter mine. The main shaft on the Doctor-Jack Pot mine was sunk 242 feet and ore of higher average grade than in 1911 was shipped, as shown by public statements.[1]

The twentieth annual report of the Elkton Co. for the calendar year 1912, dated February 10, 1913, shows that the company shipped an appreciably increased tonnage in 1912, and that

the average value of the ore has increased from $16.88 per ton in 1911, to $19.01 per ton in 1912. The tonnage marketed from your mine in 1912 is an increase of 12,659 dry tons over the preceding year. * * * We have presistently followed the recession of the water in sinking the shaft and winze, which are now to a depth of 185 feet below the tenth level, and with the water receding about 10 feet a month, we estimate that about the first of March we will be ready to cut the station on the twelfth level. * * * Your company is operating a lease on an adjoining property to the west known as the Raven and Beacon Hill lease. * * * At the close of the year we had no lessees operating upon the property.

The summary shows: Entire property, grand total, 32,519 dry tons, average gross value, $19.37; of which company work, 29,163 dry tons, average gross value, $19.01; lessees's work, mine and dump, 2,559 tons, average gross value, $23.15; company lease work, 797 dry tons, average gross value, $19.89. Grand total, average per ton, freight and treatment, $5.94; average per ton, net, $13.43.

The report of the El Paso Consolidated Gold Mining Co., dated March 3, 1913, shows that

in the year 1912 the gross ore sales were $820,960. * * * The grand total of development work was 6,039 feet. The flow from the Roosevelt tunnel continues at over 8,000 gallons per minute. * * * In the El Paso territory the water has lowered very rapidly, and upon the completion of the timbering of the main El Paso shaft from the 1,000-foot level to the tunnel level mining will then be possible in the ore bodies opened and proven on the Roosevelt tunnel level. We begin the year 1913 with the El Paso mine completely drained.

The output from the Conundrum mine of the Ethel Louise Co. decreased, as did that of the Findley and Forest Queen. The Free Coinage mine was operated continuously. An increased tonnage was shipped from the Gold Bond mine. Lessees on the Gold Dollar group shipped an increased tonnage; there was a decrease in tonnage from the El Paso-Gold King, but an increase from the Gold Sovereign mine. The output from the Golden Cycle mines decreased. A small tonnage was mined from the Hoosier mine. The Granite group was operated both by lessees and on company account. An increased tonnage was shipped from the Henry Adney mine.

The report of the Isabella Mines Co. shows that the

ore production by the company amounted to 2,181 tons, worth $30,693; by lessees, 10,098 tons, worth $202,592; from dumps, 8,730 tons, worth $76,797.

Lessees operated the cyanide leaching mill on coarse rock and sands without crushing.

A small yield was made from the Jennie Sample mine. The report of the Jerry Johnson Co., for the year ending August 31, 1912, shows that "there was shipped 13,150 tons, with gross value of $182,059." Not only was ore shipped from the Jo Dandy mine, but a large tonnage of low-grade dump ore was treated in the Kavanaugh cyanide mill on the property. The Katinka, Kitty Wells No. 2, and Emma Abbott mine of the Lady Campbell Co. were producers, but the Last Dollar mine was reported idle. The Lexington Co. shipped from the Clara D. mine. Development work was done on the Maggie mine, the output showing a decrease.

[1] Min. and Sci. Press, Nov. 23, 1912, p. 675; Eng. and Min. Jour., Dec. 12, 1912, p. 1098.

According to the annual report

there were produced from the Mary McKinney property, on company account, 10,459 tons of ore, with gross value of $272,454; by lessees, 3,086 tons, with a gross value of $53,858. During the year the following underground work was performed in addition to stopping and cutting station at ninth level, which has a depth of 920 feet: Drifts, 3,152 feet; * * * main shaft, 126 feet.

An increased output was shipped from the Midget-Bonanza mine. Ore from the Ocean View mine of the Modoc Co. was shipped to Pueblo or to sampling works. The Ophir mine was operated by lessees for several months. A heavily increased tonnage was shipped from the Dead Pine claim of the Ophir Co. The Pharmacist and Petrel mines were producers.

As shown by the nineteenth annual report (dated Feb. 3, 1913) of the Portland Gold Mining Co.,

the gross tonnage shipped to the Colorado Springs mill was 44,562 tons and the gross value $987,416, at an average value of $22.16, as compared with 50,258 tons, at an average value of $22.68, in 1911; as compared with 67,515 tons, at an average value of $18.32, in 1910; with 83,908 tons, at an average per ton of $17.14, in 1909; and with 94,311 tons, at an average of $19.45, in 1908. At the Victor mill was treated 173,361 tons with a gross value of $547,424. The grand total gross value since April 1, 1894, to December 31, 1912, was $34,361,897, and total dividends $9,157,080. * * * The future for deep mining looks extremely promising by the indications on the new sixteenth level * * * . About the first of March we intend to start sinking No. 2 shaft to the seventeenth level. * * * The water level in your property has been lowered 207 feet as the result of the drainage tunnel.

There was no output from the Pride of Cripple Creek mine, but a regular output was maintained from the Prince Albert mine. There were small yields from the Ramona, Requa-Savage, Rose Maud, Roxanna, and Sheriff mines. The Rexall Mining Co. shipped in 1912, as also did the Rubie and Lafayette mines. An increased tonnage was mined from the various properties of the Stratton-Cripple Creek Co., operated by lessees.

The report [1] for the Stratton's Independence mine for the fiscal year ending June 30, 1912, shows

that both the mine and dump continued to yield profits. * * * The output of ore from the Independence mine was 10,455 tons produced by tributers, containing gold worth $304,464, and 4,550 tons produced by the company, having a content of $116,518; in addition 1,922 tons, containing gold worth $48,599, was taken by tributers from the Washington claim, and 1,567 tons from the dump, also by tributers, containing $35,735. * * * The company also won 13,019 tons of ore which was treated at the company's plant containing $67,887 * * * . At the company's plant, 99,372 tons of dump ore as well as the 13,019 tons of mine ore were treated, yielding 18,833 ounces of gold.

The mill treated 112,391 tons, averaging $3.10 per ton.[2]

The Strong mine was operated steadily. Shipments from the Trilby mine increased.

From the United Gold Mines, according to the annual report,[3] lessees produced 16,172 tons, averaging $8.44; including 10,256 tons to the Wild Horse mill, averaging $3.38.

The Victor mine was operated continuously by lessees.

The Vindicator Gold Mining Co., in its annual report, shows

96,934 tons of crude ore were produced on company account, yielding 22.5 per cent, or 21,819 tons of shipping ore, of a gross value of $644,926, or $29.50 per ton. (The production was all from the 700-foot level to the 1,500-foot level, the greater part coming from the 1,200-foot to the 1,500-foot level). Lessees * * * produced 10,775 net

[1] Min. Mag. (London), November, 1912, p. 388.
[2] Min. and Sci. Press, Nov. 16, 1912, p. 640.
[3] Min. and Sci. Press, Mar. 8, 1913, p. 393

tons, of a gross value of $198,559, or $18.50 per ton. * * * During the month of December work was started on the 1,600-foot level. * * * During the year we have thrown all the water from our property over to the Golden Cycle to be pumped to the surface. In the early part of December the Golden Cycle started the new electrical pumps installed.

Production was made from the Little Clara and Morning Glory mines of the Work Co.

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IDAHO.

By C. N. Gerry.

PRODUCTION.

The value of the production of gold, silver, copper, lead, and zinc from 173 deep mines and 235 placers in Idaho in 1912 was $21,466,521, against $19,100,894 in 1911, an increase of $2,365,627. The production of all metals increased; the increase in gold was small, but in other metals it was considerable. Better prices, especially of silver and copper, were factors in making an increase of over 12 per cent in the total value of the State output. There was a notable gain in the production of silver and lead, especially from lead ores in Shoshone County, and a considerable increase in gold output from placer mines, which offset a decrease in gold from lode mines. The changes in the last year are given in the following table, as well as the output by years for the last nine years:

Total quantity of ore sold or treated in Idaho in 1904–1912, number of producers and content and total value of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	360	1,668,327	$1,710,365	7,666,382	5,087,518	233,096,375	2,600	$16,933,405
1905	257	1,669,038	1,075,618	8,679,093	7,321,585	259,812,428	1,228,449	19,743,620
1906	287	1,787,673	1,149,100	9,018,815	9,558,913	255,014,446	2,065,597	23,698,400
1907	359	1,690,860	1,255,911	8,415,431	10,890,731	233,823,854	6,985,732	21,793,064
1908	385	1,689,231	1,443,459	7,469,981	10,041,850	206,827,816	37,410	15,416,599
1909	324	1,772,383	1,453,822	7,041,633	9,115,489	215,986,285	1,351,010	15,660,849
1910	417	1,786,174	1,096,842	7,369,742	7,037,292	228,258,839	5,603,114	16,316,196
1911	369	2,170,897	1,372,387	8,196,136	5,152,937	272,556,525	8,340,249	19,100,894
1912	408	2,266,334	1,381,214	8,294,745	7,492,152	284,185,657	13,905,502	21,466,521
Increase (+) in 1912		+95,437	+8,827	+98,609	+2,339,215	+11,629,132	+5,565,253	+2,365,627

Compared with the output for 1911, the production of copper ore, lead ore, and lead-zinc ore increased, while the output of siliceous ore continued to decrease. Gold production from placers increased over 56 per cent.

Output of ore and production of metals in Idaho in 1912, by kinds of ore.

Source of production.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	235	.....	30,574.40	7,278	.....	.....	.....
Siliceous ore	81	88,430	29,856.42	232,583	10,573	27,981	.....
Copper ore	13	98,848	2,039.30	451,918	6,663,229	13,920	.....
Lead ore	74	1,597,661	3,854.52	7,085,596	730,773	250,774,042	.....
Zinc ore	5	1,236	.....	597	.....	.....	618,007
Copper-lead ore	2	33	.....	3,487	11,949	8,522	.....
Lead-zinc ore	5	480,126	491.59	513,286	75,628	33,361,192	13,287,495
Total	.....	2,266,334	66,816.23	8,294,745	7,492,152	284,185,657	13,905,502

ORE PRODUCTION IN 1912.

The quantity of ore sold or treated increased from 2,170,897 tons in 1911 to 2,266,334 tons in 1912, an increase of 95,437 tons, or nearly 5 per cent. As in former years, the lead ore represented the largest output, 1,597,661 tons, or 70.50 per cent. More lead-zinc ore is being utilized and separated by Macquisten tubes than formerly. In 1912 the quantity aggregated 480,126 tons, or 21.19 per cent of the total. The output of siliceous ore was 88,430 tons, or 3.90 per cent, and that of copper ore 98,848 tons, represented 4.36 per cent. The siliceous ore averaged $8.60 per ton in gold and silver; the copper ores, $3.24; the lead ore, $2.78; the zinc ore, only $0.30; and the lead-zinc ore, $0.68. The output of siliceous ore included 39,283 tons of gold ore, 49,042 tons of gold-silver ore, and 105 tons of silver ore. The first averaged per ton 4.35 ounces of gold and 0.21 ounce of silver; the second, 0.26 ounce of gold and 4.40 ounces of silver; and the last, 67.82 ounces of silver.

Subdivision of tonnage of ore sold or treated in Idaho in 1912, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	1,424	.....	1	.....	.....	.....	1,425
Adams	.....	203	.....	.....	.....	.....	203
Bear Lake	.....	.....	9	.....	.....	.....	9
Blaine	778	5	8,669	562	1	.....	10,015
Boise	9,320	.....	.....	.....	.....	.....	9,320
Bonner	193	3	57	.....	.....	.....	253
Bonneville	.....	15	.....	.....	.....	.....	15
Clearwater	13	.....	.....	.....	.....	.....	13
Custer	2,301	26,287	2,994	.....	32	.....	31,614
Elmore	5,626	.....	.....	.....	.....	.....	5,626
Idaho	4,948	.....	.....	.....	.....	.....	4,948
Lemhi	14,583	13	31,044	.....	.....	.....	45,640
Oneida	.....	.....	15	.....	.....	.....	15
Owyhee	49,201	.....	.....	.....	.....	.....	49,201
Shoshone	43	72,322	1,554,872	674	.....	480,126	2,108,037
Total	[a] 88,430	98,848	1,597,661	1,236	33	480,126	2,266,334

[a] Includes 39,283 tons of gold ore, 49,042 tons of gold and silver ore, and 105 tons of silver ore.

Nearly 4 per cent of the ore, or 82,568 tons, was treated in milling plants equipped for amalgamation or cyanidation. Gold and silver bullion was recovered valued at $682,318, or $8.26 per ton of ore treated. A small part of the bullion came from tailings treated in these mills. Of the gold in bullion, 48 per cent was won by amalgamation and 52 per cent by cyanidation. Of the silver, 6,107 ounces were from amalgamation and 195,276 ounces from cyanidation. From information received in regard to the use of mercury and potassium cyanide, it was found that only 700 pounds of mercury were consumed, against 1,648 pounds in 1911, and that 161,156 pounds of potassium cyanide were used, against 181,808 pounds of sodium and potassium cyanide in 1911. The consumption was 0.02 pound of mercury and 3.36 pounds of potassium cyanide per ton of ore treated.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Idaho in 1912, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Ada	303	147.27	31	118.89	68	$5,563
Blaine	[a] 540	263.67	118	.....	.....	5,523
Boise	[b] 8,430	1,913.10	448	.....	.....	39,823
Clearwater	13	8.08	2	.....	.....	168
Custer	1	401.22	608	.....	.....	8,668
Elmore	5,341	914.42	472	1,820.89	1,469	57,737
Idaho	[c] 4,883	2,640.72	687	.....	.....	55,010
Lemhi	[d] 13,898	5,605.17	548	.....	.....	116,206
Owyhee	[e] 49,159	958.38	3,193	12,224.08	193,739	393,620
Total	82,568	12,852.03	6,107	14,163.86	195,276	682,318

[a] Also yielded 21 tons of concentrates; [b] 55 tons; [c] 11 tons; [d] 78 tons; [e] 98 tons. These tonnages and metal content are included in table of concentrates produced.

The largest part of the ore, 1,985,527 tons, representing 87.61 per cent of the total tonnage, was concentrated. From this milling ore, some tailings, and gold-silver ore milled, 232,347 tons of concentrates were produced at a ratio of 8.50 to 1. These had a total value of $13,803,693, or a value per ton of $59.41.

The Cœur d'Alene region of Shoshone County produced nearly all the concentrates. Lead concentrate represents the largest part, or 176,704 tons. The last classification in the following table needs further separation. The quantity, 54,303 tons, is actually the tonnage of concentrates made from lead-zinc ore. Of this, 35,808 tons went to lead smelters and averaged per ton $0.28 in gold and 14.17 ounces of silver and 0.10 per cent of copper and 60.43 per cent of lead. The remainder, 18,495 tons of zinc concentrate, averaged 35.92 per cent of spelter.

Mine production of gold, silver, copper, lead, and zinc from Idaho concentrates in 1912, by counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Blaine	8,569	1,619	223.16	21,429	743	1,420,769	63,437	$86,226
Boise	353	212	537.37	1,326	968	5,446	.....	12,329
Idaho	.....	11	28.71	77	.....	82	.....	645
Lemhi	.....	78	164.03	375	1,340	12,044	.....	4,385
Owyhee	.....	98	433.93	10,298	179	1,617	.....	15,406
Shoshone	1,976,605	230,329	2,617.06	5,369,038	820,251	206,143,708	13,287,495	13,684,702
Total	1,985,527	232,347	4,004.26	5,402,543	823,481	207,583,666	13,350,932	13,803,693
Subdivision by kinds of concentrates:								
Dry or siliceous		420	1,355.44	12,182	2,520	20,192	.....	36,836
Copper		842	16.84	18,802	342,702	.....	.....	68,458
Lead		176,704	2,140.40	4,857,676	402,631	174,202,282	.....	10,937,254
Zinc		78	.....	597	.....	.....	63,437	4,744
Lead-zinc		54,303	491.58	513,286	75,628	33,361,192	13,287,495	2,756,401

The following table indicates that there was a decrease in recovery from both lead concentrates and zinc concentrates, but this was more than offset by the increase in the product from lead-zinc ore. A great portion of the Cœur d'Alene ore contains zinc as well as lead, but the material is classed as lead ore when only a lead concentrate is saved, and as a lead-zinc ore when a zinc concentrate is also saved.

Kinds of concentrates and average metallic content of each kind produced in Idaho in 1912 compared with 1911.

Kind and source of concentrates.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
Dry or siliceous:		*Value*	*Fine ounces*				
Gold and silver mills—	*Short tons.*	*per ton.*	*per ton.*	*Per cent.*	*Per cent.*	*Per cent*	
1911	689	$51.00	46.82	0.06	0.70	.....	$76.61
1912	263	81.16	43.91	.39	3.24	.....	112.37
Concentration mills—							
1911	793	9.62	3.93	.15	.02	.....	12.08
1912	157	42.50	4.04	.15	1.00	.....	46.38
Copper:							
Concentration mills—							
1912	842	.41	22.33	20.35	.....	.....	81.30
Lead:							
Gold and silver mills—							
1911	8	45.00	12.50	.....	10.24	.....	60.88
Concentration mills—							
1911	209,060	.26	24.81	.14	48.69	.....	57.58
1912	176,704	.25	27.49	.11	49.29	.....	61.89
Zinc:							
Concentration mills—							
1911	12,198	.....	.....	.....	.....	33.98	38.74
1912	78	.....	7.65	.....	.....	40.66	60.82
Lead-zinc:							
Concentration mills—							
1912	54,303	.19	9.45	.70	30.71	12.23	50.76

Of the State tonnage, 8.60 per cent, or 193,828 tons, was shipped directly to various smelting plants, and nearly all of it was treated at plants in other States. This first-class ore came largely from Shoshone, Lemhi, and Custer counties, and had a total value of $6,337,856, or an average of $32.70 per ton. There was considerable increase in all the different kinds of ore shipped, but especially in lead ore and copper ore. More than half the tonnage was lead ore shipped. Joining the value of the ore and concentrates shipped, smelters received a product valued at $20,141,549, or 93.83 per cent of the value of the entire State output.

Mine production of gold, silver, copper, lead, and zinc from Idaho crude ore shipped to smelters in 1912, by counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Ada	122	153.16	60	32	367	.....	$3,224
Adams	203	11.18	2,153	79,078	.....	.....	14,603
Bear Lake	9	.....	15	.....	13,085	.....	598
Blaine	906	409.76	16,248	2,773	399,169	41,884	39,773
Boise	37	89.84	1,214	33	660	.....	2,638
Bonner	253	26.85	14,644	7,766	52,937	.....	13,225
Bonneville	15	7.01	58	3,161	.....	.....	703
Custer	29,281	1,770.42	108,080	2,893,205	760,267	.....	614,657
Idaho	65	59.50	24	.....	.....	.....	1,245
Lemhi	31,741	1,136.86	347,614	104,674	16,953,559	.....	1,017,466
Oneida	15	.10	6	30	5,260	.....	247
Owyhee	17	376.32	605	.....	.....	.....	8,151
Shoshone	131,164	1,102.40	2,189,222	3,566,152	58,408,335	512,686	4,621,326
Total	193,828	5,143.40	2,679,943	6,656,904	76,593,639	554,570	6,337,856
Subdivision by kinds of ore:							
Dry or siliceous	1,398	1,406.82	18,900	8,053	7,789	.....	42,385
Copper	82,707	2,022.47	433,116	6,320,527	13,920	.....	1,351,687
Lead	108,986	1,714.11	2,227,920	328,142	76,571,760	.....	4,905,477
Zinc	736	.....	.....	.....	.....	554,570	38,265
Copper-lead	1	.....	7	182	170	.....	42

Crude zinc ore shipped was the most valuable crude product.

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Idaho in 1912, compared with 1911.

Kind of crude ore.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Value per ton.*	*Fine ozs. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	940	$16.02	18.42	0.38	0.39	.....	$27.08
1912	1,398	20.80	13.52	.28	.....	.....	30.32
Copper:							
1911	40,061	2.32	6.34	4.96	.....	.....	18.08
1912	82,707	.50	5.24	3.82	.....	.....	16.34
Lead:							
1911	95,840	.36	25.23	.30	35.97	.....	46.85
1912	108,986	.32	20.44	.15	35.13	.....	45.01
Zinc:							
1911	50	.....	1.98	.....	.....	35.28	41.26
1912	736	.....	.....	.....	.....	37.67	51.99
Copper-lead:							
1912	1	.....	7.00	9.10	8.50	.....	42.00
Lead-zinc:							
1911	41	1.97	8.32	.....	21.05	18.41	46.32

As far as possible the ore shipped has been separated into the oxidized and the sulphide portions with average per ton for each. The greater part of the lead ore was sulphide and of the copper ore was oxidized.

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Idaho and shipped to smelters in 1912.

Kind of ore.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	1,398	1,406.82	18,900	8,053	7,789	.....	$42,385
Copper:							
Oxidized	48,176	1,485.45	254,431	3,934,613	13,920	.....	837,019
Sulphide	34,531	537.02	178,685	2,385,914	.....	.....	514,668
Lead:							
Oxidized	23,884	579.76	290,295	86,866	13,103,446	.....	794,504
Sulphide	85,102	1,134.35	1,937,625	241,276	63,468,314	.....	4,110,973
Zinc:							
Sulphide	736	.....	.....	.....	.....	554,570	38,265
Copper-lead:							
Sulphide	1	.....	7	182	170	.....	42
Total	193,828	5,143.37	2,679,943	6,656,904	76,593,639	554,570	6,337,856

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Idaho and shipped to smelters in 1912.

Kind of ore.	Quantity.	Average.					
		Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous	1,398	$20.80	13.52	0.29	0.28	.....	$30.32
Copper:							
Oxidized	48,176	.64	5.28	4.08	.01	.....	17.37
Sulphide	34,531	.32	5.17	3.45	.....	.....	14.90
Lead:							
Oxidized	23,884	.50	12.15	.18	27.43	.....	33.26
Sulphide	85,102	.27	22.76	.14	37.29	.....	48.31
Zinc:							
Sulphide	736	.....	.....	.....	.....	37.67	51.99
Copper-lead:							
Sulphide	1	.....	7.00	9.10	8.50	.....	42.00
Total	193,828	.55	13.83	1.72	19.76	.14	32.70

GOLD.

Only a slight increase was made in gold production in Idaho, from $1,372,387 in 1911 to $1,381,214 in 1912, a difference of $8,827. The value of the deep-mine output from 173 properties was $749,185 in gold, and the gold from 235 placer mines had a value of $632,029. In 1906 gold from placers was less than half of that from deep mines. In 1912 gold from lode mines decreased to such an extent, especially in Elmore and Owyhee counties, and gold from placers, particularly those worked by dredges in Boise and Lemhi counties, has increased so much that the two totals are more nearly equal. About 76 per cent of the placer gold was won by dredging, nearly 23 per cent by hydraulic or sluicing, and less than 1 per cent from drifting. Of the gold output from lode mines, 44.68 per cent of the total State yield

came from dry or siliceous ore, 5.77 per cent from lead ore, 3.05 per cent from copper ore, and 0.74 per cent from lead-zinc ore. Siliceous ore had a recoverable value per ton of $7 in gold, lead ore $0.05, and copper ore, $0.42. Snake River supplied only $3,752 in gold, against $4,691 in 1911. Gold and silver mills recovered 40.43 per cent of the total gold output, or 27,015.89 ounces, 12,852.03 ounces by amalgamation and 14,163.86 ounces by the cyanide method. The average per ton for the former was $7.68 and for the latter $6.11. Crude ore shipped to smelters contained 5,143.40 ounces, or 7.70 per cent of the total, and concentrates 4,004.26 ounces, or 6 per cent of the total.

Source of gold production in Idaho, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Lead-zinc ore.	Total.
Ada	67.53	418.26	.....	1.06	.....	486.85
Adams	5.03	.....	11.18	.....	.....	16.21
Bingham	72.32	.....	.....	.....	.....	72.32
Blaine	4.64	782.39	.33	113.87	.....	901.23
Boise	21,757.34	2,540.31	.....	.....	.....	24,297.65
Bonner	.....	24.34	1.98	.53	.....	26.85
Bonneville	234.72	.....	7.01	.....	.....	241.73
Clearwater	1,939.40	8.08	.....	.....	.....	1,947.48
Custer	243.62	401.24	1,766.58	3.82	.....	2,415.26
Elmore	221.32	2,735.31	.....	.....	.....	2,956.63
Fremont	3.00	.....	.....	.....	.....	3.00
Idaho	1,246.62	2,728.93	.....	.....	.....	3,975.55
Kootenai	299.93	.....	.....	.....	.....	299.93
Latah	57.81	.....	.....	.....	.....	57.81
Lemhi	3,922.92	6,224.33	.....	760.01	.....	10,907.26
Lincoln	38.74	.....	.....	.....	.....	38.74
Nez Perce	21.28	.....	.....	.....	.....	21.28
Oneida	13.69	.....	.....	.10	.....	13.79
Owyhee	37.78	13,992.71	.....	.....	.....	14,030.49
Shoshone	364.84	.52	252.22	2,975.13	491.59	4,084.30
Twin Falls	21.87	.....	.....	.....	.....	21.87
Total	30,574.40	[a]29,856.42	2,039.30	3,854.52	491.59	66,816.23

[a] Includes 17,068.99 ounces from gold ores, 12,785.77 ounces from gold and silver ores, and 1.66 ounces from silver ores.

SILVER.

The production of silver increased from 8,196,136 ounces, valued at $4,343,952 in 1911, to 8,294,745 ounces, valued at $5,101,268 in 1912. There was an increase of only 98,609 ounces in quantity, but owing to the higher price of the metal, the value increased $757,316. Although the lead mines produced more ore, the silver yield from this source was much the same as in the previous year—7,085,596 ounces. A considerable increase was made in the silver yield from copper ore and there was a large decrease from siliceous ores. Siliceous ore supplied 2.80 per cent of the silver; copper ore, 5.44 per cent; lead ore, 85.42 per cent; and lead-zinc ore, 6.19 per cent. The average per ton in silver for the various ores was as follows: Siliceous ore, 2.63 ounces; copper ore, 4.57 ounces; lead ore, 4.43 ounces; zinc ore, 0.48 ounce; and lead-zinc ore, 1.07 ounces. Shoshone, Lemhi, Owyhee, and Custer counties were the main silver producing counties, but the output from Owyhee County has been steadily decreasing in recent years. Bullion from gold and silver mills supplied 201,383 ounces of silver, or 2.43 per cent of the total output, and nearly all of this was won by the cyanide method. Crude ore smelted contained 2,679,943 ounces, or

32.31 per cent of the total, and concentrates contained 5,402,543 ounces, or 65.13 per cent. Lead concentrates contained 4,857,676 ounces, or 90 per cent of the silver in concentrates.

Source of silver production in Idaho, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	16	120	.....	39	.....	.....	.....	175
Adams	3	.....	2,153	.....	.....	.....	.....	2,156
Bear Lake	.....	.....	.....	15	.....	.....	.....	15
Bingham	6	.....	.....	.....	.....	.....	.....	6
Blaine	2	2,152	77	34,962	597	7	.....	37,797
Boise	5,765	2,988	.....	.....	.....	.....	.....	8,753
Bonner	.....	12,552	760	1,332	.....	.....	.....	14,644
Bonneville	8	.....	58	.....	.....	.....	.....	66
Clearwater	517	2	.....	.....	.....	.....	.....	519
Custer	99	608	70,105	37,975	.....	3,480	.....	112,267
Elmore	68	1,941	.....	.....	.....	.....	.....	2,009
Idaho	329	788	.....	.....	.....	.....	.....	1,117
Kootenai	47	.....	.....	.....	.....	.....	.....	47
Latah	2	.....	.....	.....	.....	.....	.....	2
Lemhi	338	1,846	1	346,808	.....	.....	.....	348,993
Lincoln	2	.....	.....	.....	.....	.....	.....	2
Nez Perce	5	.....	.....	.....	.....	.....	.....	5
Oneida	1	.....	.....	6	.....	.....	.....	7
Owyhee	15	207,835	.....	.....	.....	.....	.....	207,850
Shoshone	54	1,751	378,764	6,664,459	.....	.....	513,286	7,558,314
Twin Falls	1	.....	.....	.....	.....	.....	.....	1
Total	7,278	[a] 232,583	451,918	7,085,596	597	3,487	513,286	8,294,745

[a] Includes 9,438 ounces from gold ores, 216,024 ounces from gold and silver ores, and 7,121 ounces from silver ores.

COPPER.

The production of copper in Idaho in 1912 was 7,492,152 pounds, valued at $1,236,205, against an output in 1911 of 5,152,937 pounds, valued at $644,117. The increase of 2,339,215 pounds was divided between Custer and Shoshone counties. In the former county, the Lost Packer matting plant was idle, but the White Knob mine had an enlarged output. At the Snow Storm mine both crude ore and concentrates were shipped. Copper ores produced most of the output or 88.93 per cent, and lead ores 9.75 per cent. From concentrates, 823,481 pounds, or 10.99 per cent, were recovered by smelting and from crude ore 6,656,904 pounds, or 88.85 per cent, were won. Copper ore had an average content of 3.37 per cent copper and lead ore 0.23 per cent of copper.

Source of copper production in Idaho, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	.....	.....	32	.....	.....	32
Adams	.....	79,078	.....	.....	.....	79,078
Blaine	201	1,027	2,106	182	.....	3,516
Boise	1,001	.....	.....	.....	.....	1,001
Bonner	6,669	471	686	.....	.....	7,766
Bonneville	.....	3,161	.....	.....	.....	3,161
Custer	.....	2,867,935	25,270	11,767	.....	2,904,972
Lemhi	1,507	2,571	101,936	.....	.....	106,014
Oneida	.....	.....	30	.....	.....	30
Owyhee	179	.....	.....	.....	.....	179
Shoshone	1,076	3,708,986	600,713	.....	75,628	4,386,403
Total	[a] 10,573	6,663,229	730,773	11,949	75,628	7,492,152

[a] Includes 1,194 pounds from gold ores, 7,537 pounds from gold and silver ores, and 1,842 pounds from silver ores.

LEAD.

Idaho made a record production of lead in 1912 amounting to 284,185,657 pounds, valued at $12,788,355, against an output in 1911 of 272,556,525 pounds, valued at $12,265,044. The increase of 11,629,132 pounds was made largely in Shoshone County and partly in Blaine County. Lemhi County produced more lead, but did not repeat the large increase made in 1911. The principal sources were lead ore, which supplied 88.24 per cent of the total, and lead-zinc ore, which yielded 11.74 per cent. The crude lead ore mined had an average assay of 7.85 per cent lead; and the lead-zinc ore, 3.47 per cent. The lead content of all crude ore shipped to smelters amounted to 76,593,639 pounds, and of this quantity first-class lead ore shipped to smelters, amounting to 108,986 tons, contained 76,571,760 pounds, or 35.13 per cent of lead. Concentrates shipped contained 207,583,666 pounds, or an average of 44.67 per cent lead. The lead concentrates contained 49.29 per cent and averaged in value for all metals $61.89. The crude lead ore shipped averaged 35.13 per cent and a total value per ton of $45.01.

Source of lead production in Idaho, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	.....	.....	367	.....	.....	367
Bear Lake	.....	.....	13,085	.....	.....	13,085
Blaine	2,449	.....	1,817,319	170	.....	1,819,938
Boise	6,106	.....	.....	.....	.....	6,106
Bonner	5,683	.....	47,254	.....	.....	52,937
Custer	.....	.....	760,267	8,352	.....	768,619
Idaho	82	.....	.....	.....	.....	82
Lemhi	12,044	.....	16,953,559	.....	.....	16,965,603
Oneida	.....	.....	5,260	.....	.....	5,260
Owyhee	1,617	.....	.....	.....	.....	1,617
Shoshone	.....	13,920	231,176,931	.....	33,361,192	264,552,043
Total	[a] 27,981	13,920	250,774,042	8,522	33,361,192	284,185,657

[a] Includes 8,808 pounds from gold ores, 17,482 pounds from gold and silver ores, and 1,691 pounds from silver ores.

ZINC.

The production of zinc increased from 8,340,249 pounds, valued at $475,394, in 1911 to 13,905,502 pounds, valued at $959,479, in 1912. This is an increase of 5,565,253 pounds, or 40.02 per cent, over the record output of 1911. Nearly all the zinc came from Shoshone County, the greater part of it from lead-zinc ore. Some of the mines of Shoshone County, especially in the Beaver and Summit districts, market a clean zinc product. Others, such as the Success and the Surprise, produce ore containing more zinc than lead, and requiring a separation of the two products. The larger mines have a small percentage of zinc with the lead ore. More of this last class is being separated each year. The crude ore shipped averaged 37.67 per cent in zinc, and the zinc concentrate from lead-zinc ore 35.92 per cent of zinc.

Source of zinc production, by kinds of ore, in Idaho, in 1912, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Blaine	105,321	.....	105,321
Shoshone	512,686	13,287,495	13,800,181
Total	618,007	13,287,495	13,905,502

Reduction plants.—A list of active and idle mills in the State was given in the report for the year 1911. In 1912 there were 59 active plants, against 66 in operation in 1911. Of these, 10 were equipped for amalgamation, 21 for concentration alone, 19 for amalgamation and concentration, 8 for amalgamation, concentration, and cyanidation, and 1 for cyanidation with concentration. The only smelting plant operated within the State was a lead plant treating ore from the mines at Clayton in Custer County.

MINING INDUSTRY IN IDAHO IN 1912.

The increase in the production of all metals speaks well for condition of the mining industry in Idaho in 1912. With the exception of the mining of gold ores, progress was made in all branches of the industry. The constant operation of the old lead producers gave a record lead production and increased the silver output. The development of zinc mines and the use of Macquisten tubes have given a striking impetus to the zinc industry in the State. The capacity of the plant was doubled at the Morning mine and others are contemplated for mines with similar ore in the Cœur d'Alene region. There is every indication that instead of falling off in production, the copper situation will continue to improve. Another feature in which rapid strides have been made, and in which indications of genuine improvement are shown, is the use of dredges in Idaho. Those in operation in Boise, Lemhi, and Clearwater counties have prevented the State's gold output from showing serious decrease. No railroad building of importance to the mining industry was done, and little smelting was done in the State. Three plants were idle. The one at Hahn, in Lemhi County, burned down. The lead plant at Clayton was operated part of the year.

Mine production of gold, silver, copper, lead, and zinc, in Idaho in 1912, by counties.

County.	Gold.				Silver.	
	Placers.		Deep mines.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Fine ozs.*	
Ada	67.53	$1,396	419.32	$8,668	175	$108
Adams	5.03	104	11.18	231	2,156	1,326
Bear Lake					15	9
Bingham	72.32	1,495			6	4
Blaine	4.64	96	896.59	18,534	37,797	23,245
Boise	21,757.34	449,764	2,540.31	52,513	8,753	5,383
Bonner			26.85	555	14,644	9,006
Bonneville	234.72	4,852	7.01	145	66	41
Clearwater	1,939.40	40,091	8.08	167	519	319
Custer	243.62	5,036	2,171.64	44,892	112,267	69,044
Elmore	221.32	4,575	2,735.31	56,544	2,009	1,235
Fremont	3.00	62				
Idaho	1,246.62	25,770	2,728.93	56,412	1,117	687
Kootenai	299.93	6,200			47	29
Latah	57.81	1,195			2	1
Lemhi	3,922.92	81,094	6,984.34	144,379	348,993	214,631
Lincoln	38.74	801			2	1
Nez Perce	21.28	440			5	3
Oneida	13.69	283	.10	2	7	4
Owyhee	37.78	781	13,992.71	289,255	207,850	127,828
Shoshone	364.84	7,542	3,719.46	76,888	7,558,314	4,648,363
Twin Falls	21.87	452			1	1
Total	30,574.40	632,029	36,241.83	749,185	8,294,745	5,101,268

Mine production of gold, silver, copper, lead, and zinc, in Idaho in 1912, by counties— Continued.

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Ada	32	$5	367	$16			$10,193
Adams	79,078	13,048					14,709
Bear Lake			13,085	589			598
Bingham							1,499
Blaine	3,516	580	1,819,938	81,897	105,321	$7,267	131,619
Boise	1,001	165	6,106	275			508,100
Bonner	7,766	1,281	52,937	2,382			13,224
Bonneville	3,161	522					5,560
Clearwater							40,577
Custer	2,904,972	479,320	768,619	34,588			632,880
Elmore							62,354
Fremont							62
Idaho			82	4			82,873
Kootenai							6,229
Latah							1,196
Lemhi	106,014	17,492	16,965,603	763,452			1,221,048
Lincoln							802
Nez Perce							443
Oneida	30	5	5,260	237			531
Owyhee	179	30	1,617	73			417,967
Shoshone	4,386,403	723,757	264,552,043	11,904,842	13,800,181	952,212	18,313,604
Twin Falls							453
Total	7,492,152	1,236,205	284,185,657	12,788,355	13,905,502	959,479	21,466,521

Gold production of Idaho placers by different methods in 1911 and 1912.

	Hydraulic.[a]	Drift.	Dredge.	Total.
1911 ..... fine ounces..	6,962.26	78.02	12,519.04	19,559.32
1912 ..... do....	7,093.22	209.09	23,272.09	30,574.40

[a] Includes sluicing.

Tons of ore sold or treated, number of deep mines producing, and value of ores in Idaho in 1911 and 1912, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1912	Increase (+) or decrease (−).	1911	1912	1911	1912	1911	1912
	Short tons.	*Short tons.*						
Ada	1,425	+ 1,384	2	7	$18.32	$6.17	$18.32	$6.14
Adams	203	− 315	2	4	33.72	71.93	1.64	7.66
Bear Lake	9	+ 9		1		66.44		1.00
Blaine	10,015	+ 4,355	24	32	14.36	13.13	8.25	4.17
Boise	9,320	− 8,056	8	10	5.21	5.88	5.16	5.83
Bonner	253	+ 155	10	7	49.06	52.35	43.32	37.79
Bonneville	15	+ 15		1		46.86		12.07
Cassia		− 19	1		45.63		20.84	
Clearwater	13	+ 13		2		12.92		12.92
Custer	31,614	+ 18,626	11	10	24.93	19.85	8.52	3.60
Elmore	5,626	− 34,381	9	8	6.11	10.26	6.11	10.26
Fremont		− 71	1		52.24		2.59	
Idaho	4,948	− 2,199	24	18	7.93	11.50	7.93	11.50
Kootenai		− 19	1		22.63		18.00	
Lemhi	45,640	+ 10,575	18	26	31.31	24.97	8.29	7.86
Oneida	15	+ 15		1		16.46		.33
Owyhee	49,201	+ 1,800	7	11	10.02	8.48	10.02	8.48
Shoshone	2,108,037	+103,550	34	35	8.13	8.68	1.99	2.24
Total	2,266,334	+ 95,437	152	173	8.61	9.19	2.45	2.58

[a] Value per ton, placer product excluded.

Number of producing mines, classified by chief products, in Idaho, in 1912, by counties.

County.	Placer mines.			Deep mines.											Total mines producing.
	Hydraulic.	Dredge.	Drift.	Gold.	Silver.	Gold, silver.	Gold, silver, copper.	Gold, silver, copper, lead.	Gold, silver, copper, lead, zinc.	Gold, silver, lead.	Gold, silver, lead, zinc.	Silver, lead.	Silver, copper, lead.	Silver, lead, zinc.	
Ada	3	....	....	....	....	6	....	1	....	....	....	....	....	....	10
Adams	1	....	....	....	....	....	4	....	....	....	....	....	....	....	5
Bear Lake	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
Bingham	4	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Blaine	4	....	....	....	....	1	2	17	....	5	2	1	3	a1	36
Boise	52	2	....	....	....	8	....	2	....	....	....	....	....	....	64
Bonner	....	....	....	....	....	....	2	3	....	....	....	1	1	....	7
Bonneville	5	....	....	....	....	....	1	....	....	....	....	....	....	....	6
Clearwater	26	3	....	....	....	2	....	....	....	....	....	....	....	....	31
Custer	6	1	....	....	2	2	....	....	....	2	....	1	3	....	17
Elmore	12	....	....	....	....	8	....	....	....	....	....	....	....	....	20
Fremont	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Idaho	49	....	8	1	....	17	....	....	....	....	....	....	....	....	75
Kootenai	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Latah	5	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Lemhi	12	2	....	2	....	10	1	9	....	....	....	2	a2	....	40
Lincoln	2	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Nez Perce	2	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Oneida	3	....	....	....	....	....	1	....	....	....	....	....	....	....	4
Owyhee	10	....	....	....	....	9	1	....	....	1	....	....	....	....	21
Shoshone	15	....	2	....	....	1	1	16	2	4	4	3	b3	c1	52
Twin Falls	4	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Total	217	8	10	3	2	64	13	48	2	12	6	9	12	2	408

a One contains no lead. b Two contain no lead. c Contains only zinc.

REVIEW BY COUNTIES.

ADA COUNTY.

Production of Ada County in 1912 shows increase in all metals. The output of the county was $10,064 in gold, 175 ounces of silver, 32 pounds of copper, and 367 pounds of lead, valued in all at $10,193, or an increase of $7,246. The placer product valued at $1,406 came from 3 mines. From 7 deep mines there were treated 1,425 tons of ore and old tailings having an average value of $6.14 per ton. Two deep mines in 1911 produced 41 tons of ore, having a total value of $18.32 per ton. All of the ore, with the exception of 1 ton of lead ore, was dry or siliceous in character. By amalgamation 147.27 ounces of gold and 31 ounces of silver were recovered and by cyanidation 118.89 ounces of gold and 68 ounces of silver. Crude ore shipped to smelter aggregated 122 tons, containing 153.16 ounces of gold, 60 ounces of silver, and all of the copper and lead, having a total value of $3,224, or an average value of $26.43 per ton.

Black Hornet district.—Ore was produced from 5 deep mines aggregating 402 tons, which contained $5,933 in gold, 85 ounces of silver, 32 pounds of copper, and 367 pounds of lead, valued in all at $6,006, or an average value of $14.94 per ton. The Grey Eagle mine was the principal producer, and ore from this property was treated in a neighboring 20-stamp amalgamation mill.

Highland district.—Three placer operators reported the production of $1,396 in gold and 16 ounces of silver from the banks of Boise River.

Neal district.—The mill of the Gold Eagle Mining & Milling Co., was operated on old tailings during part of the year.

Shaw Mountain district.—A small shipment of gold and silver bullion was made from one property in the district.

ADAMS COUNTY.

Four deep mines and 1 placer produced $335 in gold, 2,156 ounces of silver, and 79,078 pounds of copper, having a total value of $14,709. All of the ore (203 tons), was shipped directly to smelters and had an average value per ton of $71.93. With the exception of silver, there was a decrease in output of all metals. In 1911 two deep mines produced 518 tons of ore, valued at $33.72 per ton.

Seven Devils district.[1]—The production of the county came from this district, except a slight placer output. The principal producers were the Blue Jacket and Mountain Queen properties, operated by the Blue Jacket Copper Co. (Ltd.). Other producers were the Lewis group, River Queen, and Hobo properties. Shipments consisted of oxidized copper ore.

Meadows district.—According to the State report,[2] the Rock Flat placers will probably be tested.

BEAR LAKE COUNTY.[3]

In 1912 one deep mine reported the production of a small tonnage of lead sulphide ore having a total value of $598, or an average value of $66.44 per ton.

BINGHAM COUNTY.

From the operations of four placer properties on Snake River a production was reported of $1,495 in gold and 6 ounces of silver. In 1911 six producers yielded $1,651 in gold and 4 ounces of silver.

BLAINE COUNTY.

Total quantity of ore sold or treated in Blaine County, Idaho, in 1904–1912, and content and total value of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	9	25,030	$3,948	488,275	.....	5,423,027	.....	$279,620
1905	18	18,845	7,152	374,554	2,312	3,983,833	1,084,449	484,966
1906	17	17,844	13,599	184,337	.....	1,737,605	10,599	236,794
1907	24	14,829	27,103	170,367	35,919	2,250,164	37,077	268,175
1908	39	7,753	2,630	126,326	31,941	1,675,124	37,410	145,912
1909	17	20,373	40,402	115,303	22,740	1,762,268	71,010	182,927
1910	23	17,042	42,335	92,596	20,018	1,284,966	76,397	155,543
1911	25	5,660	21,572	47,839	9,359	705,545	29,814	81,546
1912	36	10,015	18,630	37,797	3,516	1,819,938	105,321	131,619
Increase (+) or decrease (−) in 1912		+4,355	−2,942	−10,042	−5,843	+1,144,393	+75,507	+50,073

[a] Includes placer production.

[1] Lindgren, Waldemar, The copper deposits of the "Seven Devils": Twentieth Ann. Rept., U. S. Geol. Survey, pt. 3, 1900, p. 249.

[2] Bell, R. N., Mining industry of Idaho, 1912, p. 50.

[3] Gale, H. S., Geology of the copper deposits near Montpelier, Bear Lake County, Idaho: Bull. U. S. Geol. Survey No. 430, 1910, p. 112.

Source of gold and silver in Blaine County, Idaho, in 1911 and 1912, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc	Copper-lead ore.	Lead-zinc ore.	Total.
Gold	1911	11.66	920.33	.....	110.21	.....	.....	1.35	1,043.55
	1912	4.64	782.39	0.33	113.87	.....	.....	.....	901.23
Silver	1911	2	4,396	.....	43,110	.....	.....	331	47,839
	1912	2	2,152	77	34,962	597	7	.....	37,797

Blaine County produced 10,015 tons of ore from 32 mines in 1912, as compared with 5,660 tons from 24 mines in 1911. The average recoverable value per ton in 1912 was $13.13, as against $14.36 in 1911, and the gold and silver value of this ore, which was $8.25 in 1911, decreased to $4.17 in 1912. Of the total ore produced, 8,669 tons were classified as lead ore, 778 tons as dry or siliceous, 562 tons as zinc ore, and small tonnages as copper ore and copper-lead ore. The largest part of the ore (8,569 tons) was treated at concentrating mills, yielding 1,619 tons of concentrates, which contained $4,613 in gold, 21,429 ounces of silver, 743 pounds of copper, 1,420,769 pounds of lead, and 63,437 pounds of zinc, valued in all at $86,226, or an average value per ton of $53.26. At gold and silver mills 540 tons of ore were treated by amalgamation, yielding 263.67 ounces of gold and 118 ounces of silver. The remainder of the ore (906 tons) was shipped to smelters, having a total value of $39,773.

Dome district.—The production of the district, reported from 3 deep mines, aggregated 7,859 tons of ore, containing $97 in gold, 11,313 ounces of silver, 506 pounds of copper, and 1,487,350 pounds of lead, valued in all at $74,069, or an average of $9.42 per ton. The 100-ton concentration mill of the Wilbert Mining Co. was completed and operated during part of the year on lead sulphide ore. A bulletin [1] on this region has just been published by the Survey.

Hamilton district.—Lead ore was shipped from 3 properties in the district, having a total value of $3,017, or an average of $47.14 per ton.

Lava Creek district.—A shipment of siliceous silver ore, containing lead, was made from the Iron Mountain mine.

Mineral Hill district.—Sixteen deep mines produced 744 tons of ore, containing $1,195 in gold, 9,206 ounces of silver, 1,998 pounds of copper, 140,158 pounds of lead, and 78,834 pounds of zinc, valued in all at $18,934, or an average value of $25.45 per ton. The dump of the War Dance mine was worked and the ore treated in a concentration mill, producing zinc concentrate. A shipment of oxidized iron ore, carrying more than an ounce of gold per ton, was made from the Golden Bell property. Lead sulphide ore was shipped in largest quantities from the Comet, Croesus, Minnie Moore, Jay Gould, and Nay Aug properties. A shipment of zinc ore was also made from the last-named property.

Rosetta district.—A small shipment of oxidized lead ore was made from one property.

Skeleton Creek district.—The 10-stamp mill of the El Oro Mining & Milling Co. was operated during the year on gold and silver ore from the Frazier mine, and bullion and concentrates were sold.

[1] Umpleby, J. B., Lead-silver deposits of the Dome district, Idaho: Bull. U. S. Geol. Survey No. 541–E, 1913.

Soldier district.—From 4 placer properties small shipments of bullion were made.

Vienna district.—The Mountain King property produced shipments of lead sulphide ore carrying considerable gold and silver.

Warm Springs district.—From 6 deep mines there was a production of 707 tons of ore, which contained $6,614 in gold, 12,563 ounces of silver, 608 pounds of copper, 111,599 pounds of lead, and 26,487 pounds of zinc, valued in all at $21,289, or an average value of $30.11 per ton. The Independence mine and the Starlight and Noonday properties of the Pulaski Mineral Co. were the principal producers. The former property is equipped with an 80-ton concentrating mill consisting of rolls, jigs, and tables, making a rich lead sulphide concentrate. The Starlight and Noonday produced gold ore.

BOISE COUNTY.

Total quantity of ore sold or treated in Boise County, Idaho, in 1904–1912, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	63	17,923	$294,884	38,330	500	.....	$316,891
1905	40	1,788	152,145	1,960	.....	2,064	153,426
1906	57	16,406	229,024	4,909	.....	.....	232,313
1907	68	8,369	235,276	17,553	.....	47,903	249,400
1908	57	15,854	199,307	7,029	198	13,596	203,629
1909	65	8,705	216,031	8,484	2,185	15,410	221,390
1910	68	11,444	199,430	14,443	5,957	3,001	208,117
1911	57	17,376	353,464	7,308	5,354	2,773	358,131
1912	64	9,320	502,277	8,753	1,001	6,106	508,100
Increase (+) or decrease (−) in 1912		−8,056	+148,813	+1,445	−4,353	+3,333	+149,969

[a] Includes placer production.

Source of gold and silver in Boise County, Idaho, in 1911 and 1912, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Dry or siliceous ore.	Total.
Gold	1911	12,856.48	4,242.34	17,098.82
	1912	21,757.34	2,540.31	24,297.65
Silver	1911	3,572	3,736	7,308
	1912	5,765	2,988	8,753

Ten deep mines in Boise County in 1912 produced 9,320 tons of ore, yielding $52,513 in gold, 2,988 ounces of silver, 1,001 pounds of copper, and 6,106 pounds of lead, having a total value of $54,791, or an average of $5.88 per ton. In 1911 eight deep mines produced 17,376 tons of ore valued at $90,471, or $5.21 per ton. All of the ore produced was dry or siliceous in character. At gold and silver mills using the amalgamation process 8,430 tons were treated, yielding 1,913.10 ounces of gold and 448 ounces of silver, having a total value of $39,823, or an average per ton of $4.72. Of the total ore produced, 353 tons were concentrated and 37 tons were shipped directly to smelters. The placer output, reported by 54 producers, was valued at $453,309, which is an increase of $185,649 over the output of 1911 reported by 49 operators, and was due to dredge

operations. The geology and early gold and silver production of this region are given in a Survey report [1] by Lindgren.

Banner district.—One property made a small output of gold and silver ore which was shipped.

Boise Basin district.—Operators of 5 deep mines and 43 placers reported the production of $490,023 in gold, 6,897 ounces of silver, 497 pounds of copper, and 2,306 pounds of lead, valued in all at $494,450. The deep mines produced 8,839 tons of ore, valued at $43,456, or an average of $4.92 per ton. Most of the ore, or 8,338 tons, went to gold and silver mills and yielded 1,843.37 ounces of gold, 415 ounces of silver, and 55 tons of concentrates, which contained 214.57 ounces of gold, 692 ounces of silver, 497 pounds of copper, and 2,306 pounds of lead. The placer production was $447,474 in gold and 5,724 ounces of silver. The largest placer operators were the Boston-Idaho, Coyote, Clay Gulch, Crevice Diggings, Harwood Glenn, Corcoran Bar, Leary & Brogan, and Basin Branch. Two dredges were operated by the Boston-Idaho Gold Dredging Co. The Gold Hill & Iowa was the largest productive deep mine, having a 20-stamp amalgamation and concentration mill in operation, together with a cyanide plant for the treatment of concentrates. From the Golden Age property, bullion was produced from the operation of the 50-ton amalgamation and concentration mill. The 5-stamp amalgamation mill of the Idaho-Elkhorn Mining Co. was operated intermittently for four months on ore and old tailings from the Elkhorn and Little Sammy properties. A new 10-ton amalgamation and concentration mill was erected on the property of the National Mining & Development Co. and was operated for about 60 days, producing bullion and concentrates. The concentrates were stored in the mill to be treated later by the cyanide process. The dredge of the Moline Mining Co. was not operated. The Boise Basin Improvement Co., which took the Mann & Hansen and Woodburn ground, was the largest hydraulic operator.

Deadwood Basin district.—The total output of the district was valued at $1,018, and consisted of the output from the Wilson Creek placer and bullion from the Merry Blue and Union property.

Gold Fork district.—One producer reported the output of a small quantity of gold and silver bullion from placer operations.

Hay Fork district.—From the Switzerland mine some ore, rich in gold, was produced.

Payette River district.—Two placer properties in this district produced $182 in gold and 2 ounces of silver.

West View district.—This district yielded $9,286 in gold, 826 ounces of silver, 504 pounds of copper, and 3,800 pounds of lead, valued in all at $10,048. Two deep mines produced 446 tons of ore valued at $9,375, or an average value of $21.02 per ton. A new 3-stamp amalgamation and concentration mill was erected at the property of the Payette Mining Co., and was operated for a short time, producing gold and silver bullion. The principal producer was the Leviathan group of the Whitman Mining Co., from which crude ore and concentrates were shipped. A 40-ton concentration plant was in operation at different times during the year.

Boise River district.—Four placer producers reported the output of $746 in gold and 14 ounces of silver.

[1] Lindgren, W., The mining districts of Idaho Basin and the Boise Ridge, Idaho: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 625-736.

BONNER COUNTY.

The county produced 253 tons of ore, containing $555 in gold, 14,644 ounces of silver, 7,766 pounds of copper, and 52,937 pounds of lead, valued in all at $13,224, or an average value of $52.35 per ton. There was an increase in all of the metals, aggregating $8,375 in value. In 1911 ten deep mines reported a production of 98 tons of ore, having a total value of $4,849, or an average value of $49.06 per ton. All of the ore produced was shipped directly to smelters, and 193 tons were dry or siliceous ore, 57 tons were lead ore, and 3 tons were copper ore. The smelter at Ponderay has not been in operation since 1909.

Lakeview district.—From 2 properties small shipments of crude shipping ore were made. The ore was valued at $1,594, or an average value of $35.42 per ton. The principal values were in silver.

Pend Oreille district.—Four deep mines produced 191 tons of ore, containing $544 in gold, 12,527 ounces of silver, 7,080 pounds of copper, and 40,311 pounds of lead, valued in all at $11,230, or an average of $58.80 per ton. The B. F. H., Black Jack, and Imperial properties produced siliceous silver ore, and the output from the property of the Lawrence Mining & Milling Co. was a lead sulphide ore. At the last named property a 50-ton concentration plant was erected, but was not operated in 1912.

Priest Lake district.—The Idaho-Continental property, north of Priest Lake, is to be equipped with a 300-ton concentration mill, hydroelectric power plant, sawmill, and compressor.

Surprise district.—The output of the district, near Leonia, consisted of a shipment of lead sulphide ore from the Blue Grouse property.

BONNEVILLE COUNTY.

The total output of the county, formerly part of Bingham County, from 5 placers and 1 deep mine was valued at $5,560. In 1911 three placer properties yielded an output valued at $2,863.

Mount Pisgah district.—Two placers and one deep mine produced $4,816 in gold, 64 ounces of silver, and 3,161 pounds of copper, valued in all at $5,378. The Idaho Mining & Dredge Co. operated the American placer.

Snake River district.—The entire production of the district was reported by 3 placer operators and was valued at $181.

CLEARWATER COUNTY.

The output of gold and silver from Clearwater County from 2 deep mines and 29 placers was valued at $40,577. This is a decrease of $456 from the output of 1911, when 21 placer operators reported production. All of the ore produced, or 13 tons, was treated at gold and silver mills by the amalgamation process, yielding gold and silver bullion valued at $168, or an average of $12.92 per ton.

Burnt Creek district.—Eight placers produced $3,070 in gold and 37 ounces of silver. The Boise placer was the largest producer.

Moose Creek district.—One placer operator reported a small production of gold bullion from the vicinity of Rivulet, Mont.

Pierce district.—The district produced $37,146 in gold and 482 ounces of silver from 20 placers and 2 deep mines. The principal

productions were from dredging operations. The dredge of the Sprague Co. was operated most of the year, but the new dredge of the Idaho Co. was idle practically all the year.

CUSTER COUNTY.

Ten deep mines yielded 31,614 tons of ore, including 2,300 tons of old tailings, which is 18,626 tons more than was mined by 11 producers in 1911. The total average value per ton decreased from $24.93 in 1911 to $19.85 in 1912, and the gold and silver value from $8.52 to $3.60. The output of the county, including the gold and silver production of 7 placers, was $49,928 in gold, 112,267 ounces of silver, 2,904,972 pounds of copper, and 768,619 pounds of lead, having a total value of $632,880. All of the ore produced, with the exception of one ton treated at a milling plant using the amalgamation process, was shipped directly to smelters. Of the total tonnage, 26,287 tons was copper ore, 2,994 tons lead ore, 2,301 tons dry or siliceous, and 32 tons copper-lead ore.

Alder Creek district.[1]—The White Knob mine, owned by the Empire Copper Co., was operated the entire year, producing an important and greatly increasing tonnage of copper ore. The ore, which is both oxidized and sulphide, was shipped to the Garfield smelter. The 250-ton smelter connected with the mine was idle. The Copper Basin mine was the only other producer in the district.

Bay Horse district.—From the operations of 5 deep mines, the district produced 3,014 tons of ore, containing $66 in gold, 40,975 ounces of silver, 37,037 pounds of copper, and 757,219 pounds of lead, valued in all at $65,452, or an average of $21.72 per ton. The Red Bird and Skylark properties of the Idaho Smelting & Mining Co. were the principal producers. During the year this company acquired the interests of the Clayton Mining & Smelting Co. and operated a 100-ton lead plant the latter part of the year. The bullion is rich in silver.

Loon Creek district.[2]—The entire production of the district consisted of a small quantity of gold and silver bullion reported by one placer operator. According to the printed report of the Lost Packer Mining Co.,[3] the smelting plant was not operated during the year. Development consisted of 824 feet of drifts, 291 feet of crosscuts, and 159 feet of raises. No new ore was developed and ore reserves remain the same as at the completion of the smelter run in 1911.

Sheep Mountain district.—One deep mine reported the production of lead sulphide ore.

Stanley Basin district.—This district produced $4,826 in gold and 98 ounces of silver from the operations of 5 placers. The Joe's Gulch placer was the most important producer. The dredge of the Willis Co. was operated for only a few days.

Yankee Fork district.—Compared with 1911, the output of the district was greatly increased in 1912. In the former year only $1,820 in gold and 58 ounces of silver were produced, and in 1912 the

[1] Weed, W. H., The copper mines of the United States in 1905: Bull. U. S. Geol. Survey No. 285, 1906, p. 108.

[2] Umpleby, J. B., A preliminary account of the ore deposits of the Loon Creek district, Idaho: Bull. U. S. Geol. Survey No. 530, 1912.

[3] Ann. Rept. for year ending December, 1912.

output was $8,294 in gold and 608 ounces of silver. The plant of the Sunbeam Consolidated Gold Mines Co. was operated by lessees during September and October on old tailings.

ELMORE COUNTY.

The operators of 8 deep mines reported the production of 5,626 tons of ore, including 285 tons of old tailings, which is 34,381 tons less than was produced by the same number of deep mines in 1911. The total average value of the ore increased from $6.11 in 1911 to $10.26 in 1912. All of the ore mined was treated at milling plants, and the bullion recovered by the amalgamation process contained 914.42 ounces of gold and 472 ounces of silver, and that recovered by cyanidation contained 1,820.89 ounces of gold and 1,469 ounces of silver. The placer output reported by 12 operators aggregated $4,575 in gold and 68 ounces of silver, having a total value of $4,617. In 1911 the placer output was valued at $3,570.

Bear Creek district.—Four placers and 2 deep mines produced $1,588 in gold and 28 ounces of silver, valued in all at $1,605. The 5-stamp mill of the Black Ribbon mine was operated a short time, producing gold and silver bullion. The most important placer producer was the Feather River property of the Elmore Placer Co.

Black Warrior district.—A small test shipment of gold and silver ore was made from the Snow Kettle mine, which is equipped with a 2-ton mill.

Highland district.—From Twin Springs a small lot of gold and silver bullion was produced from placer operations.

Middle Boise district.—From the operations of 2 deep mines and 2 placers, there was a production of $1,841 in gold and 189 ounces of silver. The 20-stamp mill of the Minerva mine was idle during the entire year, except to treat some ore on hand. The mills of the Atlanta Mines Co. and the Bagdad Chase Co. were also idle, giving the region the smallest production it has had in years.

Neal district.—The Homestake mine produced an important tonnage of oxidized and sulphide ore, which was treated by amalgamation and cyanidation in the mill on the property.

Pine Grove district.—Two properties in the district produced ore of milling grade, which was treated by amalgamation and cyanide processes, yielding gold and silver bullion. The Franklin mill was idle most of the year.

Twin Springs district.—Four placer operators reported a production of $2,792 in gold and 42 ounces of silver. The largest producers were the Buckhorn Spring and Lucky Boy properties.

FREMONT COUNTY.

The entire production of the county consisted of a small quantity of gold bullion produced from one placer.

IDAHO COUNTY.

Total quantity of ore sold or treated in Idaho County, Idaho, in 1904–1912, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	
1904	52	36,367	$301,478	6,760	.....	.....	$305,348
1905	45	28,181	217,943	5,159	.....	.....	221,059
1906	47	18,130	171,030	8,929	.....	.....	177,012
1907	59	13,427	110,747	2,180	3,043	.....	112,795
1908	68	15,778	192,934	9,907	233	.....	198,216
1909	57	25,765	205,212	7,421	.....	.....	209,071
1910	82	6,351	63,885	1,744	.....	.....	64,827
1911	65	7,147	75,296	1,338	312	.....	76,044
1912	75	4,948	82,182	1,117	.....	82	82,873
Increase (+) or decrease (−) in 1912		−2,199	+6,886	−221	−312	+82	+6,829

[a] Includes placer production.

In 1912 Idaho County produced $82,182 in gold, 1,117 ounces of silver, and 82 pounds of lead, having a total value of $82,873, which was $6,829 more than the total in 1911. There were 75 producing mines in the county in 1912, of which 18 were deep and 57 were placer mines. The deep mines produced 4,948 tons of ore, which yielded 2,728.93 fine ounces of gold, 788 ounces of silver, and 82 pounds of lead, valued in all at $56,901, or an average value of $11.50 per ton. In 1911, 24 deep mines produced 7,147 tons of ore having a total value per ton of $7.93. Most of the ore produced in 1912, or 4,883 tons, was treated at milling plants by amalgamation, yielding 2,640.72 ounces of gold, 687 ounces of silver, and 11 tons of concentrates, which contained 28.71 ounces of gold, 77 ounces of silver, and 82 pounds of lead, valued in all at $645, or an average of $58.64 per ton. The remainder of the ore (65 tons) was shipped directly to smelters and had a total value of $1,245, or an average of $19.15 per ton. The placer output was $25,770 in gold and 329 ounces of silver.

Big Creek district.—The only producer was the Moscow mine, which was the source of gold ore treated in the 5-stamp amalgamation mill on the property. The mine was worked only for a short time in June and July.

Camp Howard district.—One operator reported the production of a small quantity of gold and silver bullion from placer operations.

Clearwater district.—A small placer production was reported from this district by one operator, and a similar output came from Crooks Corral district.

Dixie district.—Four placers and one deep mine produced gold valued at $887 and 10 ounces of silver. The 4-stamp mill on the Penn-Dixie property was operated for a short time, producing gold and silver bullion.

Elk City district.[1]—The district production from 10 deep mines and 13 placers was $58,824 in gold and 750 ounces of silver. The deep mines produced 4,504 tons of ore having a total value of $51,421, or an average value of $11.42 per ton. Most of the ore produced, or 4,439 tons, went to gold and silver mills, yielding 2,383.79 ounces of gold, 610 ounces of silver, and 10 tons of concentrates. The remainder, 65 tons, was shipped to smelters. The largest producer

[1] Flagg, A, L., The Elk City mining district: Trans. Am. Inst. Min. Eng., 1913, p. 572.

was the South Fork mine, producing about $4,000 per month during most of the year. An important tonnage of ore was produced from the Mineral Zone mine, which was operated by lessees from June until December. The ore was treated in the mill at the Buster mine, 1½ miles distant, producing gold and silver bullion and concentrates. A 3½-foot Huntington mill, equipped for amalgamation and concentration, was erected on the Del Rio property during the year. A small tonnage of ore was treated while testing and adjusting the machinery. The placer production of the district was $7,800 in gold and 105 ounces of silver. No dredges were operated.

Florence district.—Placer product valued at $429 was recovered from 4 properties in this district.

Marshall Lake district.—Two placer operators produced small quantities of gold and silver bullion.

Newsome district.—The total output of the district was valued at $2,358 and was reported by 3 placer operators. The Newsome & Leggatt Creek property was the principal producer.

Orogrande district.—The mill on the Black Pine property was operated for a few days as a test on the ore. A small placer production was also reported from one property in the district.

Robbins district.—Lessees operated the Jumbo mine during the year, producing gold and silver through the operations of the mill on the property. Placer bullion was produced by one operator.

Simpson district.—Placer product valued at $1,110 was recovered by 7 operators. The principal products were the Dandy and Great Nugget properties.

Salmon River district.—From 4 small placer operators there was a production of $1,723 in gold and 14 ounces of silver.

Ten Mile district.—The output of the district was reported by 4 placer operators, and amounted to $1,287 in gold and 12 ounces of silver. The Alpine Bar was the principal producer.

Thunder Mountain district.—Two placer operators produced $3,129 in gold and 93 ounces of silver. Part of the output resulted from placering the Dewey Reef of the old Dewey mine.

Warren district.—Four deep mines and 9 placers produced $8,088 in gold, 166 ounces of silver, and 82 pounds of lead, having a total value of $8,194. All of the ore produced (99 tons) was treated by amalgamation. A new one-stamp amalgamation mill was erected on the Skylark and Ramshorn property and was operated for a few days. The Confidence mine was the largest producer of mill bullion. A 20-ton amalgamation and concentration mill was operated on this property. The California placer produced most of the placer bullion. It was operated by the Humboldt Mines Co.

KOOTENAI COUNTY.

The total value of the output of Kootenai County was $6,229, from placer property. This is a decrease of $4,997 from the output of 2 placers and 1 deep mine in 1911. The Cedar Creek property was worked by the hydraulic method for 7 months.

LATAH COUNTY.

The output of the county in 1912 was $1,195 in gold and 2 ounces of silver, reported by 5 placer producers. In 1911 four placer operators reported a production valued at $956.

LEMHI COUNTY.

Total quantity of ore sold or treated in Lemhi County, Idaho, in 1904–1912, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	34	31,746	$251,948	44,475	5,000	1,827,400	$357,984
1905	19	17,271	98,171	39,357	.....	1,796,000	206,355
1906	20	17,466	105,932	36,453	40,000	1,144,000	203,284
1907	36	12,527	84,212	50,572	52,461	1,932,356	230,496
1908	37	2,515	72,682	22,992	10,366	700,622	115,662
1909	17	19,827	129,808	5,675	46,246	132,071	144,450
1910	35	15,392	66,961	150,185	54,887	6,526,474	442,197
1911	32	35,065	121,189	383,039	390,660	16,854,922	1,131,503
1912	40	45,640	225,473	348,993	106,014	16,965,603	1,221,048
Increase (+) or decrease (−) in 1912		+10,575	+104,284	−34,046	−284,646	+110,6 81	+89,545

[a] Includes placer production.

Source of gold and silver in Lemhi County, Idaho, in 1911 and 1912, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Gold	1911	1,621.68	3,161.72	359.59	719.53	5,862.52
	1912	3,922.92	6,224.33	.....	760.01	10,907.26
Silver	1911	135	3,877	2,568	376,459	383,039
	1912	338	1,846	1	346,808	348,993

The reports of 26 producers show that 45,640 tons of ore were mined, which is 10,575 tons more than was produced from 18 mines in 1911. The total average value per ton decreased from $31.31 in 1911 to $24.97 in 1912, and the gold and silver value of this ore from $8.29 to $7.86. The largest part of the ore, or 31,741 tons, was shipped directly to the smelters and contained $23,502 in gold, 347,614 ounces of silver, 104,674 pounds of copper, and 16,953,559 pounds of lead, valued in all at $1,017,466, or an average value of $32.06 per ton. The ores treated by amalgamation, 13,898 tons, yielded 5,605.17 ounces of gold and 548 ounces of silver, valued in all at $116,206, or an average per ton of $8.36. There were also produced from this ore 78 tons of concentrate, containing $3,391 in gold, 375 ounces of silver, 1,340 pounds of copper, and 12,044 pounds of lead, valued in all at $4,385, or an average per ton of $56.22. Of the total ore mined, 31,044 tons were lead ore, 14,583 tons dry or siliceous, including some iron ore, and 13 tons copper ore. The placer production reported by 14 operators was $81,094 in gold and 338 ounces of silver, having a total value of $81,302, against a production made by the same number of operators valued at $33,595 in 1911. A recent bulletin of the Survey describes the various districts.[1]

Carmen Creek district.—The Oro Cache mine and the Kinney group of the Carmen Creek Mining & Milling Co. were operated and produced ore of milling grade. A few test runs were made at the 10-stamp mill on the former property at different intervals, and the

[1] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: Bull. U. S. Geol. Survey No. 528, 1913.

amalgamation and concentration plant on the latter property was operated for only a few days.

Eldorado district.—The Bohannon Bar placer, formerly worked by the hydraulic method, has been tested and a dredge will be put on the property in 1913.

Eureka district.—Two placers were productive in this district. The Mullen dredge was in operation part of the year.

Gravel Range district.—A test run of the mill on the property of the Rabbit Foot Mining Co. was made during the year, producing gold and silver bullion. The mill is of 50 tons capacity.

Gibbonsville district.—Three deep mines and 1 placer produced $9,628 in gold, 421 ounces of silver, 1,340 pounds of copper, and 12,044 pounds of lead, valued in all at $10,650. The deep mines produced 1,261 tons of ore, valued at $8.28 per ton. All of the ore was of milling grade, producing gold and silver bullion and a small tonnage of concentrates. Most of the output was from the property of the American Development, Mining & Reduction Co., through the operation of the 20-stamp amalgamation mill with 20-ton cyanide plant. Old concentrates from the Clara Morris mine were marketed.

Indian Creek district.—The Kittie Burton mine was operated continuously throughout the year, producing bullion and concentrate through the operation of the 15-stamp amalgamation and concentration mill. During the year a 5-ton cyanide plant was added to treat the concentrate which was formerly shipped. Considerable recent development is reported at this mine.

Junction district.—Four deep mines in this district produced 764 tons of ore, $103 in gold, 14,870 ounces of silver, 3,248 pounds of copper, and 417,393 pounds of lead, valued in all at $28,567, or an average of $37.39 per ton. The largest producer was the Junction Mines Co., yielding an oxidized lead ore.

Kirtley Creek district.—One deep mine and 3 placers produced $76,826 in gold, 611 ounces of silver, and a small quantity of copper, having a total value of $77,229. The Kirtley Creek Gold Dredging Co. was the largest producer. The dredge on the property was operated during the greater part of the year, even in the winter months, handling at the rate of 100,000 cubic yards per month.

Leesburg district.—The Richardson placer was the largest producer in the district. Production was also made from the Hockensmith and Nappias placers. The entire output of the district was valued at $1,815.

Mackinaw district.—From the operations of 1 deep mine and 2 placers, the output of the district was valued at $857.

Mineral Hill district.—A small tonnage of lead sulphide ore and some placer bullion was produced by 1 deep mine and 3 placers.

Pratt Creek district.—During the last half of the year the 10-stamp amalgamation mill on the property of the Climax Mining & Milling Co. was operated and produced a small quantity of gold and silver bullion.

Spring Mountain district.—The Hard Carbonate and Iron Mask properties, near Nicholia, were operated during part of the year and produced lead ore.

Texas district.—Six deep mines in the district produced 30,862 tons of ore, containing $23,191 in gold, 331,978 ounces of silver, 101,061 pounds of copper, and 16,500,035 pounds of lead, valued in all at

$986,534, or an average of $31.97 per ton. All of the ore was shipped directly to the smelters. The Pittsburg-Idaho Co. was the largest producer. The property was operated the entire year and shipments of oxidized and sulphide lead ore, at the rate of 2,000 tons per month, were made throughout the year. Oxidized lead ore from the Latest Out mine was being shipped at the rate of about 600 tons per month, and the Andy Consolidated or Allie Group, now belonging to the Gilmore Mining Co., produced many cars of oxidized iron ore containing gold and silver.

Yellow Jacket district.—Work at the Yellow Jacket mine was principally development.

Unorganized (Parker Mountain) district.—The 5-stamp mill on the Parker mine was operated and produced gold and silver bullion.

LINCOLN COUNTY.

Two placer operators on Snake River reported the production of 38.74 ounces of gold and 2 ounces of silver, having a total value of $802, against a production of 10.16 ounces of gold and 1 ounce of silver, having a total value of $211, reported by the same number of producers in 1911.

NEZ PERCE COUNTY.

A production of 21.28 ounces of gold and 5 ounces of silver, valued in all at $443, was reported by 2 placer operators in 1912. The output of Pierce district, formerly in Nez Perce County, is given under Clearwater County.

ONEIDA COUNTY.

This county produced 15 tons of ore, $285 in gold, 7 ounces of silver, 30 pounds of copper, and 5,260 pounds of lead from 1 deep mine and 3 placer properties in 1912. The total output was valued at $531, against a production valued at $255 in 1911, which was reported by 4 placer operators. All of the ore produced in 1912 was of shipping grade and had a total value of $247, or an average of $16.46 per ton.

OWYHEE COUNTY.

The total value of the production of gold, silver, copper, and lead in Owyhee County in 1912 was $417,967, as compared with $476,578 in 1911, a decrease of $58,611. There was a decrease in the production of all metals, with the exception of copper. Eleven deep mines produced 49,201 tons of ore, yielding $289,255 in gold, 207,835 ounces of silver, 179 pounds of copper, and 1,617 pounds of lead, valued in all at $417,177, or an average value of $8.48 per ton. In 1911 seven deep mines produced 47,401 tons of ore, valued at $10.02 per ton. All of the ore was siliceous in character. The larger part, or 49,159 tons, was treated at milling plants, and the bullion recovered by cyanidation contained 12,224.08 ounces of gold and 193,739 ounces of silver, and the production by amalgamation was 958.38 ounces of gold and 3,193 ounces of silver. Ore treated at these milling plants also yielded 98 tons of concentrate, which contained $8,970 in gold, 10,298 ounces of silver, 179 pounds of copper, and 1,617 pounds of lead, having a total value of $15,406, or an average value of $157.20

per ton. The remainder of the output, or 17 tons, was shipped directly to smelters and contained $7,779 in gold and 605 ounces of silver, valued in all at $8,151, or an average of $479.47 per ton. The placer production reported by 10 operators was valued at $790.

Carson district.[1]—Ten deep mines and 4 placers produced $289,421 in gold, 207,837 ounces of silver, 179 pounds of copper, and 1,617 pounds of lead, valued in all at $417,343. The deep mines produced 49,199 tons of ore, valued at $8.48 per ton. All of the ore, with the exception of 17 tons of crude smelting ore, was treated at milling plants, yielding gold and silver bullion and a small tonnage of concentrates. The De Lamar mine and cyanide mill were operated the entire year. The 10-stamp amalgamation mill of the Addie Consolidated Mining & Milling Co. was used for custom work during a short period. The Nissen stamp mill of the Banner Mining & Milling Co. was also operated for a short time. Through the operations of lessees, the Belfast claim of the Trade Dollar property was productive of milling ore. The amalgamation and concentration mill of the Bergh Mining Co. was operated. Bullion shipments were also made from the Ruth and Ontario properties. The latter property, lying between the Trade Dollar and Rich Gulch, produced rich ore, part of which was shipped.

French district.—The Cumberland mine produced a few tons of gold-silver ore, which was treated in a custom mill.

Snake River district.—Six placer operators reported a production valued at $464.

SHOSHONE COUNTY.

Total quantity of ore sold or treated in Shoshone County, Idaho, in 1904–1912, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	27	1,410,245	$46,015	6,143,001	1,424,440	225,167,443	.....	$13,592,014
1905	37	1,526,927	38,987	7,292,986	5,225,606	253,855,662	144,000	17,198,856
1906	36	1,622,975	86,607	7,944,338	6,393,940	252,022,196	2,054,998	21,133,963
1907	33	1,541,670	81,696	7,266,862	7,199,648	229,442,987	6,948,655	18,888,203
1908	43	1,551,680	80,167	6,364,552	9,042,876	204,138,418	.....	13,220,853
1909	41	1,569,332	89,418	6,201,157	8,906,944	213,558,658	1,280,000	13,724,065
1910	39	1,639,781	65,076	6,703,080	6,018,688	219,758,042	5,526,717	14,416,910
1911	50	2,004,487	86,035	7,383,899	2,926,551	254,837,009	8,310,435	16,306,680
1912	52	2,108,037	84,430	7,558,314	4,386,403	264,552,043	13,800,181	18,313,604
Increase (+) or decrease (−) in 1912		+103,550	−1,605	+174,415	+1,459,852	+9,715,034	+5,489,746	+2,006,924

[a] Includes placer production.

Source of gold and silver in Shoshone County, Idaho, in 1911 and 1912, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Gold	1911	514.66	23.78	172.96	2,998.14	7.74	444.66	4,161.94
	1912	364.84	.52	252.22	2,975.13	.....	491.59	4,084.30
Silver	1911	103	2,409	201,758	6,635,624	33,669	510,336	7,383,899
	1912	54	1,751	378,764	6,664,459	.....	513,286	7,558,314

[1] Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, pp. 75–256.

With the exception of a small decrease in the production of gold, there was a large increase in all the metals produced in Shoshone County in 1912. The total output of the county was valued at $18,313,604, which is 85.31 per cent of the State total. The ore produced by 35 deep mines aggregated 2,108,037 tons, which is 103,550 tons more than was produced by 34 deep mines in 1911. The total average value of the ore increased from $8.13 in 1911 to $8.68 in 1912, and the gold and silver value from $1.99 to $2.24. Most of the ore, or 1,554,872 tons, was a lead product; 480,126 tons were lead-zinc ore; 72,322 tons, copper ore; 674 tons, zinc ore; and 43 tons siliceous ore. The larger part of the ore mined, or 1,976,605 tons, and 268 tons of old tailings, were concentrated, producing 230,329 tons of concentrates, which contained $54,099 in gold, 5,369,038 ounces of silver, 820,251 pounds of copper, 206,143,708 pounds of lead, and 13,287,495 pounds of zinc, valued in all at $13,684,702, or an average of $59.41 per ton. Different kinds of ore of shipping grade were shipped directly to smelters, the dry or siliceous ore, amounting to 43 tons, contained 0.52 ounce of gold, 1,751 ounces of silver, and 1,076 pounds of copper; copper ore, amounting to 56,181 tons, contained 235.40 ounces of gold, 359,962 ounces of silver, 3,366,284 pounds of copper, and 13,920 pounds of lead. Lead ores of shipping grade aggregated 74,266 tons and contained 866.49 ounces of gold, 1,827,509 ounces of silver, 198,792 pounds of copper, and 58,394,415 pounds of lead; zinc sulphide ores to smelters amounted to 674 tons, containing 512,686 pounds of zinc. The placer production of the county, reported by 17 operators, aggregated $7,542 in gold and 54 ounces of silver, against an outout in 1911 of $10,639 in gold and 103 ounces of silver reported by 16 producers.

Beaver district.—The output of the district from 8 placers and 1 deep mine was $3,067 in gold, 28 ounces of silver, and 217,056 pounds of zinc, valued in all at $18,061. The Bird, New Year, and Upper Horseshoe were the principal placer producers. The Interstate Callahan Mining Co. took over the Amazon Manhattan, Callahan and Interstate properties, partly in Placer Center district. The Callahan is reported to have a rich lead-silver ore and the Amazon Manhattan a good zinc ore.

Coeur d'Alene district.—The Silver City placer was productive of bullion by drift mining.

Eagle district.—The production from 2 placers and 1 deep mine was valued at $27,524. The Jack Waite mine was operated the entire year, producing a rich lead sulphide ore, which, however, contains little silver. Much development work was accomplished.

Evolution district.—Seven mines in this district produced 339 tons of ore, containing $54 in gold, 17,996 ounces of silver, 3,831 pounds of copper, and 68,814 pounds of lead, valued in all at $14,850, or an average of $43.81 per ton. The 150-ton concentration mill of the Charles Dickens mine was operated a short time and produced lead concentrates containing gold, silver, and copper. Two small lots of ore rich in silver were shipped from the Nellie mine, near Osburn. The Yankee Boy mine was operated during October, November, and December and produced lead-sulphide ore.

Hunter district.[1]—The output of the district from four deep mines was 585,611 tons of ore, which contained $23,215 in gold, 1,378,562 ounces of silver, 3,845,920 pounds of copper, 51,703,506 pounds of lead, and 2,770,456 pounds of zinc, valued in all at $4,023,427, or $6.87 per ton. In 1911 the same number of mines produced 494,376 tons of ore, valued at $3,051,800, or an average of $6.17 per ton. Most of the ore produced, or 503,203 tons, was concentrated, yielding 46,981 tons of concentrate. There were increases in output of all the metals, the most notable being in zinc. The Morning mine, which was the largest producer, was operated the entire year. The second unit of 128 tubes has been added to the Macquisten plant for the treatment of zinc tailings. According to the statement given the county assessor, there were 402,600 tons extracted, having a gross value of $2,078,787. Costs were as follows—extraction, $839,584; transportation and reduction, $812,644; improvements and repairs, $101,768; leaving a net profit of $324,790.

The mill is perhaps the most interesting in the Coeur d'Alenes, but only its salient features can be touched on here. It comprises two virtually separate plants. In one the galena is concentrated by gravitational methods; in the other sphalerite, which, being of nearly the same specific gravity as siderite, is not amenable to such methods, is concentrated by flotation. The processes employed to save the galena are highly elaborated and involve repeated grinding, much of the material being finely ground in Hardinge conical pebble mills. The Macquisten flotation process[2] is the one employed to save the sphalerite. The mill losses of both lead and zinc are still considerable. They are probably carried off for the most part in the large amount of slime which results from the repeated grinding. At the time of visit experiments were being made on other flotation processes, which are likely to be installed in the near future and to result in a much higher saving than that hitherto obtained.

The report of the company[3] gives the total production of this and other properties in the county as follows:

There were mined at all of the properties 836,947 tons (wet weight) of ore, of which 46,087 tons were first class. There were milled 762,550 tons (dry weight) of ore, an average of 63,546 tons per month, being a considerable increase in tonnage over last year.

The large increase of first class shipped was due to the doubling of the amount of low-grade, first class sorted at the Morning mine and to the sorting-plant operations at Wardner. The tonnage of first class from Mace decreased approximately 3,000 tons.

There were produced during the year 118,734 tons of lead concentrates and shipping ore, averaging 42.9 per cent lead and 20.8 ounces of silver per ton, and 2,532 tons of zinc concentrates averaging 46.93 per cent zinc. Of this total 46,087 tons were first class, or shipping ore, which carried from 22.2 per cent to 52.2 per cent lead and averaged 33.7 per cent. The first class shipped from Wardner averaged 44.9 per cent, from Mace 40.6 per cent lead, and from the Morning 27.7 per cent lead. One thousand eight hundred and sixty-nine tons were shipped from the Omaha lease, averaging 26.6 per cent lead and 47.7 ounces in silver per ton, not included in the above 46,087 tons first class from the Federal operations proper. The Omaha lease ore also contained 27,233 pounds copper. * * *

The development work for the year at the producing mines amounted to 18,947 feet, as against 17,152 feet last year, of drifting, raising, sinking, and crosscutting. * * *

During the past year a great deal of experimental work has been done and several important changes have been made at the Morning mill.

First—Tables.—Twelve Deister slime tables were substituted for the direct feed vanners. The settling capacity for these machines was increased considerably by the addition of 21 large tanks, 8 in the main building and 13 outside, with suitable building for them. A 6-deck Wilfley slime table, a James sand table, and a Deister sand table were installed for experimental purposes and tested out on different kinds of feed.

Second—Grinding machinery.—A 6-foot Hardinge ball mill was added, and after thorough testing and experimenting the 8-foot Hardinge pebble mills were found the

[1] Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. U. S. Geol. Survey No. 540-E, 1913.

[2] Described by O. B. Hofstrand, Trans. Am. Inst. Min. Eng., No. 73, 1913.

[3] Ann. Rept. Federal Mining & Smelting Co., fiscal year ending Aug. 31, 1912.

best suited and most economical for the fine crushing of our ores, and five more of this size have been ordered, and suitable buildings, foundations, and feed tanks for them are now ready. A 7-foot by 12-foot P. & M. cylindrical tube mill has also been installed and will be used for the fine crushing of our Wilfley tails in the future.

Third—Zinc plant.—Another unit of 128 tubes has been added to Macquisten plant for the recovery of zinc from our tailings. A new, and badly needed, corrugated iron repair shop and storeroom, also corrugated iron oil house with concrete floor, have been built and are in use, as also has an addition to the assay office.

The Gold Hunter mine was operated at a loss, according to the statement to the assessor, which follows: There were 114,803 tons extracted, having a gross value of $263,421. The costs were as follows—extraction, $280,046, which includes cost of transportation, and reduction; improvements and repairs, $18,193.

The amount of ore mined per day at the time of the recent visit was about 340 tons. In the mill about 40 tons a day is picked out of the sorting belt as waste and crude ore, the crude ore amounting to about 3 tons a day. The bulk of the ore is concentrated by means of Hartz jigs, Wilfley tables, and Frue vanners. The constitution of much of the ore necessitates fine grinding, which is accomplished by means of Huntington mills. The only unusual feature of the process is the saving of an iron concentrate, which is used as a flux and which contains more silver than the average ore. No zinc is saved, and the proportion of that metal is kept below 10 per cent, so that no penalty is exacted at the smelter.[1]

The Snow Storm mine was operated at a profit and produced shipping concentrates as well as crude ore. There were 71,992 tons extracted, having a gross value of $674,039. The actual cost of extraction was $167,472; transportation, which includes cost of reduction, $322,990; improvements and repairs, $94,798; leaving a net profit of $88,778.

The gross production of the mine to December 1, 1911, was $8,944,000. The ore of the Snow Storm mine consists of small particles of copper minerals disseminated in quartzite. That which was being mined at the time of the former examination in 1904 was or the most part oxidized and consisted largely of carbonate. A leaching plant that was being constructed in that year for the treatment of the ore was operated successfully for several years. It was found, however, that the sulphide ore, which preponderated in depth, could not be treated economically by a leaching process, and the leaching plant has been replaced by a concentrator whose present capacity is about 100 tons a day. Much of the ore is still shipped crude, the separation of crude ore from milling ore being effected partly in the mine by "shovel sorting" and partly by hand sorting. The proportion shipped crude varies according to the demand for siliceous ore of this kind.

The tenor of the crude ore in copper is about 3.5 per cent. Owing to its high proportion of silica—about 90 per cent—it finds no steady market, but is sold in small lots to smelters that need silica. The fact that the use of siliceous converter linings is decreasing makes the ore more difficult to dispose of than formerly.

The concentrating ore contains about 2.75 per cent of copper and is concentrated to a product that contains 20 to 25 per cent. The concentrates are all sent to the Tacoma smelter.

The ore is concentrated by ordinary wet gravitational processes. The chief difficulty arises from the minute division of the ore minerals, which necessitates very fine grinding. The saving was not much better than 50 per cent at the time of the visit, but has since been increased by the installation of certain improvements.

It appears from the figures of production that the ore yields on an average about 2 ounces of silver for each 20 pounds (that is, for each "per cent") of copper, but that the silver is more liable than the copper to loss in concentration, the silver ratio in the concentrates being about half as great as in the average ore.[2]

The Alice mine was in operation from the first of the year until the latter part of July under lease and bond. The lease was given up at that time and the mine remained closed until the middle of

[1] Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. U. S. Geol. Survey No. 540–E, 1913, p. 24.
[2] Idem, pp. 43–44.

October when a new lease was taken and the property operated until the close of the year. Royalties amounted to $9,519 and expenses $1,213.

Lelande district.—The yield of ore from 8 deep mines aggregated 501,951 tons, which contained $21,254 in gold, 3,084,281 ounces of silver, 307,959 pounds of copper, and 78,267,451 pounds of lead, valued in all at $5,490,935, or an average of $10.94 per ton. Compared with the production of 1911, there was decrease in output of all the metals. Of the total ore produced, 472,000 tons were treated at concentration mills, producing 56,502 tons of concentrates, and 29,683 tons were shipped directly to smelters.

The Standard-Mammoth or Mace mine of the Federal Mining & Smelting Co. was operated 10 months of the year, and 12,000 feet of development work was done. Since this property is nearly exhausted, and since the ore continues in Greenhill Cleveland ground adjoining, the Standard-Mammoth mine plant and mill were leased to the newly organized Greenhill Cleveland Co., controlled by the Federal, and work was continued in November and December in the new ground. The assessor's figures for the Standard-Mammoth are as follows: Number of tons extracted, 154,920, having a gross value of $1,306,999; and the costs were, extraction, $747,711; transportation and reduction, $380,550; improvements and repairs, $5,741, leaving a net profit of $172,996.

Since the Mace mill[1] is one of the oldest mills in the district, it became necessary during the year to do considerable retimbering and lining up of line shafting. It was also necesssry to renew many of the launders, and to discard the old V settling tanks which were too rotten to repair. These tanks were replaced by Esperanza deslimers and 8-foot Callow tanks. Clean water for the tables was obtained by filtering the overflow from the Huntington feed storage tank. New hydraulic classifiers were also installed and several Wilfley tables rebuilt. Five additional vanners were installed. These were second-hand machines which were in stock. Two sets of worn-out rolls were also replaced by more efficient second-hand machines from stock on hand.

The No. 5 Gates crusher was moved to No. 6 sorting plant at Mace, and 4 plunger type ore feeders installed at the ore bins. These changes effected a labor saving of $7 per day. A 50-ton mill storage bin was rebuilt to replace a 150-ton bin, which was too rotten to be repaired.

The Hercules mine output has been steadily increasing and the mine was constantly operating throughout the year. The new tunnel No. 5 was not completed during the year, but 4,000 feet of work was done. Shipping ore is sorted at Burke and milling ore concentrated at the Wallace mill, which has a gross capacity of 750 tons. Of the products, crude ore and concentrates, about one-third is crude ore, which contains considerable silver. Since the Tacoma smelter was overhauled to treat copper ores, much of the Hercules output is shipped to East Helena. Dividends were not published. The statement to the assessor gives 34,195 tons of crude ore and concentrates extracted, having a gross value of $2,174,045. Costs were as follows: Extraction, $563,209; transportation, $221,902; reduction, $543,110; improvements and repairs, $130,060; leaving a net profit of $715,763.

According to the statement given the county assessor, the Hecla Mining Co. extracted 138,588 tons of ore, having a gross value of $1,058,940. The cost of extraction was $394,025; transportation and reduction, $301,772; improvements and repairs, $27,532, leaving a net profit of $335,612. The Hecla mine at Burke was in continuous

[1] Ann. Rept. Federal Mining & Smelting Co. for year ending August 31, 1912.

operation, treating about 300 tons of ore per day and shipping about 600 tons of crude ore per month. Dividends of $300,000 were declared. The shaft has reached the 1,600-foot level.

The Greenhill-Cleveland mine, which produced rich ore and concentrate in November and December, is a continuation of the Standard Mammoth mine, owned by the Federal Mining & Smelting Co. The new company has leased the mine, plant, and equipment, and also the Mace mill No. 2 at Wallace. The assessor's figures follow: Ore extracted, 39,144 tons; gross value, $432,557; cost of extraction, $172,627; transportation and reduction, $108,215; improvements and repairs, $151,715.

The Marsh Mining Co. began production in May, and from that time until the close of the year crude ore and concentrates were produced. The product was treated in a 175-ton concentration mill, located 9 miles from the mine. The county assessor's figures give a gross tonnage extracted of 19,256 tons, which had a total value of $168,072. The cost of extraction was $103,337; transportation and reduction, $53,423; improvements and repairs, $16,401; showing a net loss of $5,089. The 400-ton concentration mill of the Frisco Mining Co. was idle, but a small tonnage of first-class lead ore was produced from the property. At the close of the year the property was sold to the Federal Mining & Smelting Co.

Placer Center district.—Two mines in the district produced 83,516 tons of sulphide ore, containing $181 in gold, 46,611 ounces of silver, 10,024 pounds of copper, 1,605,430 pounds of lead, and 9,928,000 pounds of zinc, valued in all at $787,777, or an average of $9.43 per ton. With the exception of a small tonnage of crude shipping ore, all of the product was treated at concentration mills, producing lead concentrate and zinc concentrate. The Success mine was operated during the entire year, and produced, according to county figures, 11,533 tons of lead and zinc concentrates having a gross value of $414,026. Cost of extraction, transportation, and reduction was $208,089; improvements and repairs, $20,000, leaving a net profit of $185,937. Shipments were increased until an average of between 1,400 and 1,500 tons of zinc concentrate were being shipped per month, as well as a small tonnage of lead concentrate. The ratio of concentration is about 5 to 1 and the mill was treating 200 tons per day, making a saving said to be 85 per cent of the ore contents. The lead concentrates contain considerable silver, but the zinc product contains practically none. Dividends of $195,000 were declared in 1912.

The Rex mine produced a small tonnage of lead sulphide ore. The 400-ton mill on the property was idle during the entire year. This plant was leased at the end of the year by the Tamarack-Custer Consolidated Co., a consolidation of the Custer mine and Tamarack & Chesapeake property, from which regular shipments are promised for 1913.

St. Joe district.—The output of the district was made by 1 deep mine and 5 placers and had a total value of $2,036. One carload of copper ore was shipped from the Bullion mine. The Monitor mine, a former producer, is described by the Survey.[1]

[1] Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. U. S. Geol. Survey No. 540-E, 1913, p. 36. Collier, A. J., Ore deposits of the St. Joe River basin, Idaho: Bull. U. S. Geol. Survey No. 285, 1906. Pardee, J. T., Geology and mineralization of the upper St. Joe River basin, Idaho: Bull. U. S. Geol. Survey No. 470, 1911.

Summit district.—The ore produced from 4 deep mines aggregated 26,115 tons. All of this, with the exception of 955 tons shipped to smelters, was concentrated and produced 2,851 tons of concentrate. The total output of ore contained $803 in gold, 23,238 ounces of silver, 724 pounds of copper, 3,760,357 pounds of lead, and 555,369 pounds of zinc, valued in all at $222,750, or an average of $8.53 per ton. One placer operator produced a small quantity of gold and silver bullion. The largest part of the output came from the Monarch mine and mill. The company went into the hands of a receiver the 1st of April, and from that time until the middle of December the property was operated by lessees. Lead concentrate, zinc concentrate, and a small tonnage of crude shipping ore were produced. The Bear Top & Oro Fino mill was operated and produced rich lead concentrates. Lead-zinc ore was mined from the Black Horse mine and was treated in the 100-ton concentration mill on the property, producing a lead concentrate and a zinc concentrate. Ore was hand sorted from the Terrible Edith mine and both lead and zinc products were shipped to the smelters.

Yreka district.—From 7 deep mines there were sold or treated 909,671 tons of ore, from which were recovered $31,216 in gold, 3,005,170 ounces of silver, 215,048 pounds of copper, 128,579,071 pounds of lead, and 329,300 pounds of zinc, valued in all at $7,723,659, or an average of $8.49 per ton. There were increases in output of all of the metals except copper. Of the total ore produced, 17,061 tons were shipped directly to smelters and the remainder, 892,610 tons, was concentrated, making 108,473 tons of concentrate, containing 1,317.64 ounces of gold, 2,542,679 ounces of silver, 154,244 pounds of copper, 113,262,148 pounds of lead, and 329,300 pounds of zinc.

The mine and mill of the Bunker Hill & Sullivan Mining & Concentrating Co. were in operation the entire year, with the exception of a slight interruption on account of fire. In the concentration plant [1] an average of 1,100 tons of ore were treated daily, giving the largest silver-lead output of the State. The county assessor's figures are as follows: Ore extracted, 421,600 tons; gross yield, $3,435,825; cost of extraction, $1,081,073; cost of transportation and reduction, $1,215,134; improvements and repairs, $120,597; net profit, $1,019,021.

The Stewart Mining Co. not only made constant shipments of ore to Wallace, where an average of nearly 500 tons of ore per day was milled, but in the latter part of the year was earning from $10,000 to $20,000 per month, according to the press. Development amounting to 2,750 feet was accomplished, and ore is taken to the railroad through the new lower tunnel, which has an electric haulage system. According to the statement to the assessor, there were 179,506 tons of ore extracted, having a gross value of $1,471,556; cost of extraction was $439,973; transportation and reduction, $504,519; improvements and repairs, $131,718; leaving a net profit of $395,345.

The Last Chance mine of the Federal Mining & Smelting Co. produced about 500 tons of ore per day, part of which was hand sorted and shipped to smelters. The property has been reported to be nearly exhausted, or at least that part which was to be worked by the Federal Co. after the settlement of the suit with the Bunker

[1] Handy, R. S., The No. 2 unit of the mill of the Bunker Hill & Sullivan Mining & Concentrating Co.: Trans. Am. Inst. Min. Eng., vol. 43, 1913, p. 685.

Hill Co., but the company report indicates that considerable new ore is being found. The assessor's statement follows: Ore extracted, 250,000 tons; gross yield, $1,259,457; cost of extraction, $677,667; transportation and reduction, $420,350; improvements and repairs, $5,349; net profit, $156,091. The company's fiscal report stated that 9,705 feet of work was done on the property.

The ratio of the silver contents to the lead in ore mined at Wardner decreased about 5 per cent during the year. The ratio of silver to lead in concentrates also showed about 5 per cent decrease. * * *

At Wardner the milling ore in sight has decreased about 37 per cent, but the total metal content has decreased only 31 per cent. At present rate of extraction the ore in sight would last about 10 months, but there is a large amount of unprospected territory from which we are constantly putting more ore in sight, and there is a considerable quantity of old filling which may be worked at a small profit. It is expected that a considerable amount of new ore will be put in sight to partly balance the amount extracted.

The operation of the sorting plant has continued to be very satisfactory, especially as it enables the handling of a large tonnage of low-grade material that could not otherwise be profitably worked.

At the end of the last fiscal year 65 per cent of reserve in sight at this mine was above the Sweeny level, which now has been increased to 77.5 per cent, and it is in this territory that we expect to find the larger amount of new ore possible to find during the next two years.

Dividends of the company, including profits from mines in other districts, were $749,131. Ore from the Ontario mine was treated in a 150-ton leased mill, producing lead concentrate. Lead sulphide ore was also shipped directly to the smelter. According to the county assessor's figures, the mine produced 44,316 tons of shipping ore, of which the gross yield was $492,803. Cost of extraction was $133,502; transportation and reduction, $157,215; improvements and repairs, $33,718; leaving a net profit of $168,367. The Surprise mine was operated about three months, producing lead-zinc sulphide ore, which was separated in the 50-ton concentration mill on the property. In the statement to the assessor ore extracted was given as 3,000 tons and the gross yield as $29,753. Extraction of ore cost $13,009; transportation and reduction, $12,230; improvements and repairs, $25,239, leaving a net profit of $4,513. Copper ore and lead ore of shipping grade were produced from the Caledonia mine, but by no means as much as formerly. Idleness most of the year was caused by litigation. The county assessor's figures are as follows: Ore extracted, 690 tons; gross yield, $39,019; cost of extraction, $67,066; transportation and reduction, $10,032; improvements and repairs, $17,956; showing a net loss of $56,035.

TWIN FALLS COUNTY.

Four placer operators near Twin Falls produced $453 in gold and silver. This shows a decrease from the production of 1911 when 10 operators produced $2,051 in gold and 6 ounces of silver.

WASHINGTON COUNTY.

This county was not productive during the year.

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MONTANA.

By V. C. Heikes.

PRODUCTION.

For the calendar year 1912 the gold, silver, copper, lead, and zinc contained in bullion, ore of shipping grade, and concentrates from the combined mine output of 604 producers in Montana had a value of $64,754,613, as against an output valued at $46,955,287 made by 610 producers in 1911. The increase in value of the total output, amounting to $17,799,326, was caused by an increase in silver of $1,477,803, in copper of $17,000,951, and in lead of $45,683, which was partly offset by a decrease in gold of $85,336 and in zinc of $639,775. Mines in Silver Bow County are credited with the largest output of ore, aggregating 5,243,935 tons, valued at $60,539,927. This ore contained chiefly copper (the value of which amounted to 78.5 per cent of the total value of all metals for the State), with important additional values in gold, silver, and zinc. The value of the metallic output of Madison County, next in importance, was $890,689, of which 77.3 per cent was for placer gold. Jefferson County followed with a mine output valued at $692,739, of which 45.3 per cent was for silver. Blaine County (formerly Chouteau) yielded an output valued at $452,133, of which the gold value from deep mines constituted the largest part, or 95 per cent.

At gold and silver mills 205,409 tons of ore, or 3.6 per cent of the total ore mined, was treated by amalgamation and cyanidation processes, by which were recovered 50,284.45 ounces of gold, or 28.7 per cent of the total, and 68,443 ounces of silver, or 5.3 per cent of the total. Smelters treated 1,534,522 tons of concentrates, from which were recovered 32,263.86 ounces of gold, 8,597,953 ounces of silver, 218,708,512 pounds of copper, 4,033,891 pounds of lead, and 26,792,550 pounds of zinc, with a total value of $44,071,810. The smelters also treated 839,383 tons of crude ore, containing 53,660.20 ounces of gold, 4,039,623 ounces of silver, 84,679,643 pounds of copper, 3,412,858 pounds of lead, and 126,331 pounds of zinc, with a total value of $17,728,060. Therefore the smelters received ore and concentrates containing 48.9 per cent of the gold, 99.2 per cent of the silver, all of the copper, lead, and zinc, and 96.6 per cent of the total value of the deep-mine output.

Montana's production of ore, with its content for nine years, is as follows:

Tons of ore sold or treated in Montana, 1904–1912, number of producers, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	210	4,643,092	$4,267,062	12,817,285	290,681,572	2,299,291	.....	$48,974,381
1905	332	5,020,137	4,794,083	13,231,300	304,723,526	6,264,998	1,560,000	60,709,155
1906	370	5,497,971	4,469,014	11,980,705	290,700,975	4,462,979	6,579,000	69,257,083
1907	436	4,148,496	3,286,212	9,317,605	220,108,792	3,748,304	243,100	53,670,592
1908	566	4,266,022	3,057,640	10,356,199	251,667,795	4,596,570	1,640,000	42,036,710
1909	619	5,421,185	3,791,510	12,378,714	312,058,011	2,983,430	9,359,724	51,429,694
1910	578	5,079,446	3,730,486	12,162,857	284,808,553	4,106,292	31,638,184	48,358,253
1911	610	4,940,303	3,710,571	11,985,196	272,847,705	6,431,575	43,810,145	46,955,287
1912	604	5,552,164	3,625,235	12,731,638	309,738,873	7,446,749	26,918,881	64,754,613
Increase (+) or decrease (−) in 1912		+611,861	−85,336	+746,442	+36,891,168	+1,015,174	−16,891,264	+17,799,326

[a] Includes placer production.

ORE PRODUCTION IN 1912.

The production of 5,552,164 tons of ore in 1912 shows an increase of 611,861 tons in quantity and in total value per ton from $9.36 in 1911 to $11.52 in 1912, and in gold and silver contained in this ore from $1.90 to $1.92 per ton. Silver Bow County mines produced the largest tonnage of ore, aggregating 5,243,935 tons, of which 97.1 per cent was copper ore, 136,457 tons zinc ore, 20,413 tons siliceous ore, and 152 tons lead ore. Blaine and Fergus counties yielded the largest quantity of siliceous ores, which contained principally gold and silver. Mines in Broadwater County, at Radersburg, produced largely iron sulphides, containing principally gold and a little silver and copper. Those near Elkhorn, in Jefferson County, and in the Georgetown district of Deer Lodge County produced most of the oxidized iron ores containing precious metals. The dry or siliceous ores mined were largely of milling grade and aggregated 298,308 tons. Of this tonnage, 48,837 tons were milled in amalgamation plants; 163,028 tons, including some old tailings, were milled in cyanidation mills; 9,657 tons were concentrated; and 76,648 tons of crude ore and 138 tons of tailings were smelted. About 20,000 tons of the dry or siliceous ores smelted were iron sulphides containing values in gold and silver. These ores milled or smelted were again classified into gold ores, silver ores, and gold-silver ores. The gold-silver ores predominated and aggregated 230,364 tons, containing $6.99 in gold and 5.65 ounces of silver per ton, and 0.23 per cent of copper, and 0.13 per cent of lead; the gold ores, 65,593 tons in quantity, yielded $6.55 in gold and 0.10 ounce of silver per ton; the silver ores, 351 tons in quantity, produced 12 cents in gold and 29.17 ounces of silver per ton, 0.19 per cent of copper, and 2.38 per cent of lead. The copper ores mined aggregated 5,094,432 tons, of which 4,339,811 tons were of milling grade, producing 1,496,476 tons of concentrate, averaging 36 cents in gold, 5.37 ounces of silver, 7.30 per cent of copper, and in value $27.75 per ton.

The copper concentrates were shipped to the smelter with 753,381 tons of crude copper ores, which averaged 22 cents in gold, 3.46 ounces of silver, 5.54 per cent of copper, and in value $20.63 per ton. Most of the 20,993 tons of lead ore mined was milled, producing from 13,613 tons of low-grade ore, 3,436 tons of lead concentrate averaging $3.99 in gold, 24.83 ounces of silver, 0.08 per cent of copper, 39.02 per cent of lead, and in value $54.66 per ton. The lead concentrates, with 7,380 tons of crude lead ore, were shipped to smelters and the crude lead ore averaged $4.25 in gold, 24.48 ounces of silver, 0.29 per cent of copper, 14.75 per cent of lead, and in value $33.54 per ton. All of the zinc ore mined was milled and concentrated and all of the copper-lead ores and lead-zinc ores mined were directly smelted. The average metallic content and values per ton of the concentrates and crude ores smelted appear in the chapters following.

The total output of each kind of ore mined is as follows:

Output of ore and production of metals in Montana in 1912, by kinds of ore.

Source of production.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	152	.....	39,010.52	5,852	.....	.....	.....
Siliceous ore	302	298,308	98,779.72	1,318,505	1,066,385	627,552	.....
Copper ore	63	5,094,432	34,200.83	10,655,055	308,274,462	3,527	.....
Lead ore	97	20,993	2,181.28	266,014	48,436	4,860,009	.....
Zinc ore	4	136,552	1,096.32	402,679	231,424	1,235,566	26,863,339
Copper-lead ore	4	1,788	102.07	80,688	118,166	680,173	.....
Lead-zinc ore	1	91	.....	2,845	.....	39,922	55,542
Total	.....	5,552,164	175,370.74	12,731,638	309,738,873	7,446,749	26,918,881

Each kind of ore produced from mines in 18 counties is given as follows:

Subdivision of tonnage of ore sold or treated in Montana, in 1912, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	716	70	52	.....	949	.....	1,787
Blaine	82,561	.....	.....	.....	.....	.....	82,561
Broadwater	20,007	.....	190	.....	.....	.....	20,197
Cascade	1,154	.....	6,252	.....	.....	.....	7,406
Deer Lodge	1,814	.....	.....	.....	.....	.....	1,814
Fergus	68,684	.....	15	27	.....	.....	68,726
Granite	8,841	1,527	430	.....	.....	.....	10,798
Jefferson	33,601	4,477	4,144	.....	.....	91	42,313
Lewis and Clark	36,163	98	582	.....	.....	.....	36,843
Lincoln	41	.....	8,610	68	.....	.....	8,719
Madison	21,328	11	350	.....	.....	.....	21,689
Meagher	.....	.....	33	.....	.....	.....	33
Missoula	2,225	121	16	.....	.....	.....	2,362
Park	179	.....	.....	.....	.....	.....	179
Powell	527	1,189	152	.....	89	.....	1,957
Ravalli	54	.....	.....	.....	.....	.....	54
Sanders	.....	26	15	.....	750	.....	791
Silver Bow	20,413	5,086,913	152	136,457	.....	.....	5,243,935
Total	298,308	5,094,432	20,993	136,552	1,788	91	5,552,164
Value per ton in gold and silver	$9.56	$1.42	$9.94	$1.98	$28.93	$19.23	$1.92

GOLD.

The production of gold decreased from 179,498.87 fine ounces, valued at $3,710,571, in 1911 to 175,370.74 fine ounces, valued at $3,625,235 in 1912, or a decrease of 4,128.13 ounces in quantity and $85,336 in value. Deep or lode mines in Silver Bow County yielded the largest amount of gold (valued at $793,236), followed by Fergus County, with $441,021, and by Blaine County (formerly Chouteau), with $431,270. The largest yield of placer gold was made in Madison County, which was credited with $689,197, followed by Lewis and Clark County, with $48,204. Six dredging plants, 4 operating in Madison County, 1 in Lewis and Clark, and 1 in Missoula, extracted gold from the gravels amounting to $710,387, or 88.09 per cent of the placer gold output, which was $806,419 in 1912. In 1911 the placer output was valued at $684,801. At amalgamation and cyanide mills $1,039,471 in gold was produced with an average recovery of $5.06 per ton of ore and tailings treated. Ores treated at concentration mills, producing concentrate, contained $666,954 in gold, averaging 0.435 cents per ton. The crude ore of shipping grade to smelters contained $1,109,255 in gold, or an average of $1.32 per ton. No important gold discoveries, either placer or lode, were reported in 1912.

Source of gold production in Montana, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	
Beaverhead	139.71	3,736.37	1.16	29.91	.....	50.60	3,957.75
Blaine	.....	20,862.69	.....	.....	.....	.....	20,862.69
Broadwater	182.42	17,220.75	.....	123.38	.....	.....	17,526.55
Cascade	.....	93.70	.....	101.59	.....	.....	195.29
Deer Lodge	10.30	1,237.58	.....	.....	.....	.....	1,247.88
Fergus	2.95	21,332.97	.....	1.42	.....	.....	21,337.34
Gallatin	6.00	.....	.....	.....	.....	.....	6.00
Granite	112.09	4,948.72	5.75	31.00	.....	.....	5,097.56
Jefferson	102.80	7,262.33	268.92	849.04	.....	.....	8,483.09
Lewis and Clark	2,331.87	9,437.66	32.31	93.52	.....	.....	11,895.36
Lincoln	235.05	52.48	.....	583.70	.....	.....	871.23
Madison	33,339.91	7,703.65	18.48	182.20	.....	.....	41,244.24
Meagher	23.90	.....	.....	.58	.....	.....	24.48
Missoula	845.55	397.78	1.79	.....	.....	.....	1,245.12
Park	34.68	84.76	.....	.....	.....	.....	119.44
Powell	1,291.90	531.83	464.74	157.03	.....	35.70	2,481.20
Ravalli	283.33	23.66	.....	.....	.....	.....	306.99
Sanders	.....	.....	11.66	.24	.....	15.77	27.67
Silver Bow	68.06	3,852.79	33,396.02	27.67	1,096.32	.....	38,440.86
Total	39,010.52	98,779.72	34,200.83	2,181.28	1,096.32	102.07	175,370.74

SILVER.

The yield of silver in Montana in 1912 was 12,731,638 fine ounces, valued at $7,829,957, an increase of 746,442 ounces in quantity and of $1,477,803 in value. Silver is contained principally in the copper ores and any increase in its production is the result of a greater copper output. The largest increase was made in Silver Bow County, which is credited with a production of 11,352,106 ounces, or 89.16 per cent of

the total silver output for 1912. Of this quantity, the copper ores contained 10,555,306 ounces, and important quantities of silver also came from siliceous ores and zinc ores, each kind of ore in this county containing more silver than in any other county. At gold and silver mills the largest quantity of silver recovered by amalgamation was from ores mined in Lewis and Clark County, and by cyanidation from ores produced in Blaine and Lewis and Clark counties.

Source of silver production in Montana, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Beaverhead	15	14,730	1,091	2,236	.....	69,382	.....	87,454
Blaine	.....	33,924	.....	.....	.....	.....	.....	33,924
Broadwater	19	10,763	.....	4,649	.....	.....	.....	15,431
Cascade	.....	35,547	.....	103,061	.....	.....	.....	138,608
Deer Lodge	2	434	.....	.....	.....	.....	.....	436
Fergus	.....	10,949	.....	109	.....	.....	.....	11,058
Granite	14	387,473	2,751	24,593	.....	.....	.....	414,831
Jefferson	18	371,575	57,180	78,891	.....	.....	2,845	510,509
Lewis and Clark	431	26,238	3,933	14,535	.....	.....	.....	45,137
Lincoln	15	7	.....	21,050	.....	.....	.....	21,072
Madison	5,094	33,670	91	6,617	.....	.....	.....	45,472
Meagher	2	.....	.....	1,003	.....	.....	.....	1,005
Missoula	44	16	396	236	.....	.....	.....	692
Park	6	324	.....	.....	.....	.....	.....	330
Powell	168	2,140	34,275	4,915	.....	2,606	.....	44,104
Ravalli	17	11	.....	.....	.....	.....	.....	28
Sanders	.....	.....	32	709	.....	8,700	.....	9,441
Silver Bow	7	390,704	10,555,306	3,410	402,679	.....	.....	11,352,106
Total	5,852	1,318,505	10,655,055	266,014	402,679	80,688	2,845	12,731,638

COPPER.

The production of copper increased from 272,847,705 pounds, valued at $34,105,963, in 1911, to 309,738,873 pounds, valued at $51,106,914, in 1912, a gain of 36,891,168 pounds in quantity and of $17,000,951 in value. The Summit Valley or Butte district contributed all but 1,516,326 pounds of the total. The ores of Jefferson County yielded the next largest quantity, or 776,072 pounds, followed by Broadwater County. Crude ore smelted in 1912 yielded 84,679,643 pounds, or an average of 5.04 per cent. The sulphide copper ores of smelting grade predominated and averaged 5.56 per cent of copper, while the oxidized copper ores contained only 4.42 per cent of copper. The copper-lead sulphide and oxidized ores contained, respectively, 3.08 and 3.50 per cent of copper. Included in this crude ore sent to smelters were copper precipitates containing 6,333,918 pounds of copper recovered from mine waters and the washings from old tailings by the use of scrap iron as a precipitant. Concentrates produced at milling plants contained 218,708,512 pounds of copper, nearly all of which was from copper concentrates, which averaged 7.30 per cent of copper.

Source of copper production in Montana, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Total.
Beaverhead	897	15,785	475	.....	66,423	83,580
Broadwater	283,163	.....	2,297	.....	.....	285,460
Cascade	432	.....	5,947	.....	.....	6,379
Deer Lodge	51	.....	.....	.....	.....	51
Fergus	.....	.....	274	.....	.....	274
Granite	31,252	134,399	661	.....	.....	166,312
Jefferson	398,212	345,604	32,256	.....	.....	776,072
Lewis and Clark	4,655	11,357	1,063	.....	.....	17,075
Madison	17,826	1,117	897	.....	.....	19,840
Meagher	.....	.....	1,875	.....	.....	1,875
Missoula	.....	10,069	641	.....	.....	10,710
Powell	7,018	84,626	.....	.....	4,725	96,369
Sanders	.....	5,149	162	.....	47,018	52,329
Silver Bow	322,879	307,666,356	1,888	231,424	.....	308,222,547
Total	1,066,385	308,274,462	48,436	231,424	118,166	309,738,873

LEAD.

The production of lead aggregated 7,446,749 pounds, valued at $335,104, as against 6,431,575 pounds, valued at $289,421, in 1911. The greatest increase was in Cascade County, followed by Lincoln, Silver Bow, and Sanders counties. The decrease was greatest in Jefferson and Beaverhead counties. The largest production was in Cascade County, credited with 2,259,494 pounds, followed by Jefferson County, with 1,589,588 pounds, Silver Bow County, with 1,296,283 pounds, and Lincoln County, with 1,109,907 pounds. Crude ore sent to smelters contained nearly half of the total output, or 3,412,858 pounds, of which 2,178,145 pounds were contained in crude lead ores averaging 14.75 per cent of lead. Concentrates produced 4,033,891 pounds, of which the lead concentrates contained 2,681,864 pounds, averaging 39.02 per cent of lead.

Source of lead production in Montana, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	5,949	.....	20,468	.....	541,067	.....	567,484
Broadwater	307	.....	52,234	.....	.....	.....	52,541
Cascade	77,917	.....	2,181,577	.....	.....	.....	2,259,494
Fergus	.....	.....	11,863	.....	.....	.....	11,863
Granite	.....	.....	89,597	.....	.....	.....	89,597
Jefferson	511,134	3,339	1,035,193	.....	.....	39,922	1,589,588
Lewis and Clark	17,725	.....	103,269	.....	.....	.....	120,994
Lincoln	.....	.....	1,109,907	.....	.....	.....	1,109,907
Madison	4,617	188	147,523	.....	.....	.....	152,328
Meagher	.....	.....	8,235	.....	.....	.....	8,235
Missoula	.....	.....	5,337	.....	.....	.....	5,337
Powell	6,748	.....	24,558	.....	11,150	.....	42,456
Sanders	.....	.....	12,686	.....	127,956	.....	140,642
Silver Bow	3,155	.....	57,562	1,235,566	.....	.....	1,296,283
Total	627,552	3,527	4,860,009	1,235,566	680,173	39,922	7,446,749

ZINC.

The output figured as spelter aggregated 26,918,881 pounds, valued at $1,857,403, in 1912, as against a yield of 43,810,145 pounds, valued at $2,497,178, in 1911. In 1910 there were 31,638,184 pounds of spelter reduced from Montana ores. Concentrates recovered from ores of Silver Bow County at a zinc milling plant represent nearly all the Montana output. Crude zinc ores were shipped from mines in Lincoln, Jefferson, and Fergus counties.

Source of zinc production in Montana, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Fergus	15,301	.....	15,301
Jefferson	.....	55,542	55,542
Lincoln	55,488	.....	55,488
Silver Bow	26,792,550	.....	26,792,550
Total	26,863,339	55,542	26,918,881

MINING INDUSTRY IN MONTANA IN 1912.

Aside from a production of copper and silver greatly increased over the output of recent years, the mining industry was characterized by a large amount of development work in the mines and by improvements in machinery to handle the ore. Increased use of electric haulage underground and the progressive substitution of compressed-air hoists [1] for the old steam hoists on the surface were the most notable features of mining work.

Metallurgical experiments for the treatment of the lower-grade copper ores were carried out at several points in Montana. At Anaconda the mill of the Anaconda Copper Co. is being partly remodeled following an improved flow sheet developed at the Great Falls plant. Many concentrating machines were tested with varying success and also a process for the reduction of slimes and tailings, which promises well. The old smelting plant erected in 1889 at Great Falls [2] for the treatment of copper ores mined at Butte is to be replaced by a new plant, with the exception of the blast furnaces. There will be no changes in the Great Falls electrolytic refinery.

Good progress was made during the year in the electrification of the Butte, Anaconda & Pacific Railway from the mines at Butte to the reduction works at Anaconda, and the road should be in full operation some time during the year 1913. On November 1 the Georgetown extension of the Butte, Anaconda & Pacific Railway was completed through Warm Springs Canyon to the Southern Cross mine. This branch line will be operated by steam locomotives.

Another announcement made is that the building of a railroad which was commenced about a year ago and progressed as far as completing the grade from Three Forks to Radersburg, is to be completed and in operation by May 1, 1913. When completed the line will be 62 miles long.

[1] Described in Min. and Sci. Press, Nov. 2, 1912, p. 554.
[2] Ann. Rep. Anaconda Copper Mining Co. for year ending Dec. 31, 1912.

The former agreement between the mining companies at Butte and the workmen expired during the year. Soon after the agreement expired a new contract for three years was made, providing for a minimum wage of $3.50 per day underground and $3 on the surface. When copper sells between 15 and 17 cents per pound, this rate is to be increased 25 cents. When copper is over 17 cents, the rate for underground work is to be $4, and when over 18 cents, $3.50 will be paid for surface work.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1912, by counties.

County.	Gold.				Silver.		Copper.		Lead.		Zinc.		Total value.
	Placers.		Deep mines.										
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Fine ounces.*		*Pounds.*		*Pounds.*		*Pounds.*		
Beaverhead	139.71	$2,888	3,818.04	$78,926	87,454	$53,784	83,580	$13,791	567,484	$25,537			$174,926
Blaine			20,862.69	431,270	33,924	20,863							452,133
Broadwater	182.42	3,771	17,344.13	358,535	15,431	9,490	285,460	47,101	52,541	2,364			421,261
Cascade			195.29	4,037	138,608	85,244	6,379	1,053	2,259,494	101,677			192,011
Deer Lodge	10.30	213	1,237.58	25,583	436	268	51	8					26,072
Fergus	2.95	61	21,334.39	441,021	11,058	6,801	274	45	11,863	534	15,301	1,056	449,518
Gallatin	6.00	124											124
Granite	112.09	2,317	4,985.47	103,059	414,831	255,121	166,312	27,442	89,597	4,032			391,971
Jefferson	102.80	2,125	8,380.29	173,236	510,509	313,963	776,072	128,052	1,589,588	71,531	55,542	3,832	692,739
Lewis and Clark	2,331.87	48,204	9,563.49	197,695	45,137	27,759	17,075	2,817	120,994	5,445			281,920
Lincoln	235.05	4,859	636.18	13,151	21,072	12,959			1,109,907	49,946	55,488	3,829	84,744
Madison	33,339.91	689,197	7,904.33	163,397	45,472	27,966	19,840	3,274	152,328	6,855			890,689
Meagher	23.90	494	.58	12	1,005	618	1,875	309	8,235	371			1,804
Missoula	845.55	17,479	399.57	8,260	692	426	10,710	1,767	5,337	240			28,172
Park	34.68	717	84.76	1,752	330	203							2,672
Powell	1,291.90	26,706	1,189.30	24,585	44,104	27,124	96,369	15,901	42,456	1,910			96,226
Ravalli	283.33	5,857	23.66	489	28	17							6,363
Sanders			27.67	572	9,441	5,806	52,329	8,634	140,642	6,329			21,341
Silver Bow	68.06	1,407	38,372.80	793,236	11,352,106	6,981,545	308,222,547	50,856,720	1,296,283	58,333	26,792,550	1,848,686	60,539,927
Total	39,010.52	806,419	136,360.22	2,818,816	12,731,638	7,829,957	309,738,873	51,106,914	7,446,749	335,104	26,918,881	1,857,403	64,754,613

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Montana in 1912, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Blaine	82,561			20,862.68	33,924	$452,133
Broadwater	[a] 12	158.32	42			3,299
Cascade	25			10.59	483	516
Deer Lodge	812	301.73	44			6,264
Fergus	[b] 68,145	9.50	7	17,145.38	6,845	358,837
Granite	25	25.01	2	[c] 333.11	3,987	9,856
Lewis and Clark	[d] 30,957	7,334.20	6,308	[e] 1,434.85	11,526	192,241
Lincoln	41	52.48	7			1,089
Madison	[f] 18,890	899.78	416	953.55	4,363	41,250
Missoula	2,225	397.78	16			8,233
Park	171	44.37	310	13.59	6	1,393
Powell	171	49.72	80			1,076
Ravalli	25	15.44	7			323
Silver Bow	1,349	38.98	3	203.38	67	5,053
Total	205,409	9,327.31	7,242	40,957.14	61,201	1,081,563

[a] Also yielded sulphide concentrate 1 ton.
[b] Also yielded 112 tons of concentrate.
[c] Includes bullion from 1,647 tons of old tailings.
[d] Also yielded 117 tons of concentrate.
[e] Includes bullion from 4,809 tons of old tailings
[f] Also yielded 770 tons of concentrate.

Mine production of gold, silver, copper, lead, and zinc, from Montana concentrates in 1912, by counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Broadwater		1	12.02	59				$284
Cascade	5,003	2,001	80.23	64,268	5,676	1,571,957		112,859
Fergus		112	2,296.29	1,708				48,519
Jefferson	9,600	644	116.48	60,416	2,475	102,423		44,581
Lewis and Clark	57	136	313.03	3,836	3,287	14,038		10,004
Lincoln	8,610	1,435	583.70	21,050		1,109,907		74,958
Madison		770	1,868.74	9,561	4,353			45,228
Silver Bow	4,473,970	1,529,423	26,993.37	8,437,055	218,692,721	1,235,566	26,792,550	43,735,377
Total	4,497,240	1,534,522	32,263.86	8,597,953	218,708,512	4,033,891	26,792,550	44,071,810
Subdivision by kinds of concentrates:								
Dry or siliceous		1,663	4,606.56	75,580	10,115	116,461		148,618
Copper		1,496,476	25,897.06	8,034,376	218,461,297			41,522,595
Lead		3,436	663.93	85,318	5,676	2,681,864		187,815
Zinc		32,947	1,096.31	402,679	231,424	1,235,566	26,792,550	2,212,782

Kinds of concentrates and average metallic content of each kind produced in Montana in 1912.

Kind and source of concentrates.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
Dry or siliceous:		*Value per ton.*	*Fine ounces per ton.*				
Gold and silver mills—	*Short tons.*			*Per cent.*	*Per cent.*	*Per cent.*	
1911	1,436	$68.29	24.10	0.38	.....	.....	$82.02
1912	1,000	92.62	14.81	.33	0.53	.....	103.30
Concentration mills—							
1912	663	3.93	91.66	.26	7.99	.....	68.34
Copper:							
Concentration mills—							
1911	1,255,572	.38	5.62	7.69	.....	.....	22.58
1912	1,496,476	.36	5.37	7.30	.....	.....	27.75
Lead:							
Concentration mills—							
1911	2,485	4.01	66.48	.18	25.88	.....	62.99
1912	3,436	3.99	24.83	.08	39.02	.....	54.66
Gold and silver—							
1911	21	34.81	7.57	.75	10.35	.....	50.00
Zinc:							
Concentration mills—							
1911	61,165	.28	8.03	1.09	.69	35.75	48.65
1912	32,947	.69	12.22	.35	1.87	40.66	67.16

Mine production of gold, silver, copper, lead, and zinc from Montana crude ore shipped to smelters in 1912, by counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaverhead	1,787	3,818.04	87,439	83,580	567,484	.....	$172,029
Broadwater	20,185	17,173.79	15,311	285,460	52,541	.....	413,894
Cascade	2,378	104.47	73,857	703	687,537	.....	78,637
Deer Lodge	1,002	935.85	390	51	.....	.....	19,594
Fergus	581	1,883.22	2,498	274	11,863	15,301	42,100
Granite	8,846	4,627.35	410,780	149,512	89,597	.....	376,989
Jefferson	32,713	8,263.81	450,075	773,597	1,487,165	55,542	646,022
Lewis and Clark	1,020	481.41	23,036	13,788	106,956	.....	31,206
Lincoln	68	.....	.....	.....	.....	55,488	3,829
Madison	2,799	4,182.26	26,038	15,487	152,328	.....	111,879
Meagher	33	.58	1,003	1,875	8,235	.....	1,309
Missoula	137	1.79	632	10,710	5,337	.....	2,433
Park	8	26.80	8	.....	.....	.....	559
Powell	1,786	1,139.58	43,856	96,369	42,456	.....	68,342
Ravalli	29	8.22	4	.....	.....	.....	171
Sanders	791	27.67	9,441	52,329	140,642	.....	21,341
Silver Bow	765,220	10,985.36	2,895,255	83,195,908	60,717	.....	15,737,726
Total	839,383	53,660.20	4,039,623	84,679,643	3,412,858	126,331	17,728,060
Subdivision by kinds of ore:							
Dry or siliceous	76,648	43,835.59	1,171,487	1,054,825	511,091	.....	1,823,672
Copper	753,381	8,205.20	2,603,907	83,463,892	3,527	.....	15,542,720
Lead	7,380	1,517.34	180,696	42,760	2,178,145	.....	247,567
Zinc	95	.....	.....	.....	.....	70,789	4,885
Copper-lead	1,788	102.07	80,688	118,166	680,173	.....	101,838
Lead-zinc	91	.....	2,845	.....	39,922	55,542	7,373

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Montana in 1912, compared with 1911.

Kind of crude ore.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	72,135	$14.54	18.16	0.19	0.95	.....	$25.50
1912	76,648	11.82	15.28	.69	.33	.....	23.79
Copper:							
1911	566,044	.30	4.48	6.43	.....	.....	18.75
1912	753,381	.22	3.46	5.54	.....	.....	20.63
Lead:							
1911	6,419	7.81	25.99	.27	16.46	.....	36.95
1912	7,380	4.25	24.48	.29	14.75	.....	33.54
Zinc:							
1911	.....	.....	.....	.....	.....	.....	.....
1912	95	.....	.....	.....	.....	37.26	51.42
Copper-lead:							
1911	1,177	.86	77.30	4.43	33.57	.....	83.11
1912	1,788	1.18	45.13	3.30	19.02	.....	56.95
Lead-zinc:							
1911	128	.....	.....	.....	6.81	29.69	39.98
1912	91	.....	31.26	.....	21.93	30.51	81.07

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Montana and shipped to smelters in 1912.

Kind of ore.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous ore	76,648	43,835.59	1,171,487	1,054,825	511,091	.....	$1,823,672
Copper:							
Oxidized	13,453	133.90	11,647	1,188,770	188	.....	206,086
Sulphide	739,928	8,071.30	2,592,260	82,275,122	3,339	.....	15,336,634
Lead:							
Oxidized	3,457	898.68	62,097	28,049	730,274	.....	94,258
Sulphide	3,923	618.66	118,599	14,711	1,447,871	.....	153,309
Zinc:							
Oxidized	27	.....	.....	.....	.....	15,301	1,056
Sulphide	68	.....	.....	.....	.....	55,488	3,829
Copper-lead:							
Oxidized	949	50.59	69,382	66,423	541,067	.....	79,024
Sulphide	839	51.48	11,306	51,743	139,106	.....	22,814
Lead-zinc:							
Sulphide	91	.....	2,845	.....	39,922	55,542	7,378
Total	839,383	53,660.20	4,039,623	84,679,643	3,412,858	126,331	17,728,060

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Montana and shipped to smelters in 1912.

Kind of ore.	Quantity.	Average.					
		Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous	76,648	0.57	15.28	0.69	0.33	.....	$23.79
Copper:							
Oxidized	13,453	.01	.86	4.42	.....	.....	15.32
Sulphide	739,928	.01	3.50	5.56	.....	.....	20.73
Lead:							
Oxidized	3,457	.26	17.96	.40	10.56	.....	27.26
Sulphide	3,923	.16	30.23	.19	18.45	.....	39.08
Zinc:							
Oxidized	27	.....	.....	.....	.....	28.33	39.11
Sulphide	68	.....	.....	.....	.....	40.80	56.31
Copper-lead:							
Oxidized	949	.05	73.11	3.50	28.51	.....	83.27
Sulphide	839	.06	13.47	3.08	8.29	.....	27.19
Lead-zinc:							
Sulphide	91	.....	31.26	.....	21.93	30.52	81.09
Total	839,383	.06	4.81	5.04	.20	.007	21.12

Tonnage of ore sold or treated, number of mines producing, and average value per ton of ores in Montana in 1911 and 1912, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1912	Increase (+) or decrease (−).	1911	1912	1911	1912	1911	1912
Beaverhead	1,787	− 368	11	16	$70.76	$96.27	$45.44	$74.26
Blaine[b]	82,561	+ 82,561	.....	2	.....	5.48	.....	5.48
Broadwater	20,197	− 7,575	27	32	22.75	20.67	21.88	18.22
Cascade	7,406	+ 4,444	10	14	32.10	25.93	18.80	12.05
Chouteau	.....	− 69,493	2	.....	6.61	.....	6.61	.....
Deer Lodge	1,814	− 3,842	13	8	18.93	14.25	18.76	14.25
Fergus	68,726	− 29,820	6	9	3.74	6.54	3.68	6.52
Granite	10,798	+ 1,441	32	33	35.11	36.08	34.50	33.17
Jefferson	42,313	− 27,301	76	53	9.23	16.32	7.59	11.51
Lewis and Clark	36,843	− 7,007	43	52	6.12	6.34	5.98	6.11
Lincoln	8,719	+ 4,077	4	4	10.75	9.16	2.84	2.99
Madison	21,689	− 7,076	111	103	11.84	9.14	11.38	8.68
Meagher	33	− 34	3	2	30.75	39.66	2.06	19.06
Missoula	2,362	− 2,165	3	6	3.79	4.51	3.50	3.66
Park	179	+ 121	3	6	35.31	10.90	12.14	10.90
Powell	1,957	− 579	19	20	23.84	35.47	19.83	26.37
Ravalli	54	− 171	1	2	14.83	9.16	6.03	9.16
Sanders	791	+ 655	3	4	26.15	26.98	5.07	8.06
Silver Bow	5,243,935	+673,993	63	86	9.35	11.54	1.35	1.48
Total	5,552,164	+611,861	430	452	9.36	11.52	1.90	1.92

[a] Value per ton, placer product excluded.

[b] Blaine was formerly Chouteau County.

Number of producing mines, classified by chief products, in Montana in 1912, by counties.

County.	Placer mines.			Deep mines.											Total mines producing.
	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Copper.	Gold, silver.	Gold, silver, copper.	Gold, silver, copper, lead.	Gold, silver, copper, lead, zinc.	Gold, silver, lead.	Silver, copper, lead.	Silver, lead.	Silver, copper.	Silver, lead, zinc.	
Beaverhead	4	....	....	1	....	6	5	2	....	1	1	....	....	....	20
Blaine	....	....	....	....	....	2	....	....	....	....	....	....	....	....	2
Broadwater	6	....	....	2	....	8	7	5	....	10	....	....	....	....	38
Cascade	....	....	....	....	....	....	....	4	....	9	....	1	....	....	14
Deer Lodge	1	....	....	....	....	7	1	....	....	....	....	....	....	....	9
Fergus	1	....	....	....	....	8	....	....	1	....	....	....	....	....	10
Gallatin	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Granite	5	....	....	....	....	7	15	5	....	4	....	....	2	....	38
Jefferson	10	....	....	....	....	8	14	14	1	13	1	1	1	....	63
Lewis and Clark	35	1	1	3	....	22	3	10	....	11	....	1	2	....	89
Lincoln	3	....	....	....	....	2	....	....	....	1	....	....	....	[a]1	7
Madison	12	1	....	3	....	38	37	8	....	17	....	....	....	....	116
Meagher	4	....	....	....	....	....	....	2	....	....	....	....	....	....	6
Missoula	24	1	1	....	....	2	1	....	....	....	1	1	1	....	32
Park	4	....	....	....	....	6	....	....	....	....	....	....	....	....	10
Powell	25	....	....	....	....	5	8	1	....	5	....	1	....	....	45
Ravalli	4	....	....	....	....	2	....	....	....	....	....	....	....	....	6
Sanders	....	....	....	....	....	....	1	1	....	1	1	....	....	....	4
Silver Bow	8	....	....	....	2	[b]26	50	5	1	....	....	1	....	[c]1	94
Total	147	3	2	9	2	149	142	57	3	72	4	6	6	2	604

[a] Contains only zinc. [b] Contains no gold. [c] Contains no lead.

PRODUCTION BY COUNTIES.

BEAVERHEAD COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Beaverhead County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	15	2,155	$44,855	102,864	137,577	830,572	$153,946
1912	20	1,787	81,814	87,454	83,580	567,484	174,926
Increase (+) or decrease (−) in 1912		−368	+36,959	−15,410	−53,997	−263,088	+20,980

[a] Includes placer production.

The output of ore by 16 deep mines and 4 placers in 1912 showed a metallic production contained in bullion and 1,787 tons of ore valued at $174,926. All of the ore produced was shipped directly to the smelters and contained $78,926 in gold, 87,439 ounces of silver, 83,580 pounds of copper, and 567,484 pounds of lead, valued in all at $172,029, or an average value per ton of $96.27. The output of ore was 368 tons less in 1912 than was mined by 11 operators in 1911. Copper-lead ore predominated with a production of 949 tons. There were also 716 tons of dry or siliceous ore, 70 tons of copper ore, and 52 tons of lead ore. The placer yield contained $2,888 in gold and 15 ounces of silver, against a yield of $1,455 in gold and 5 ounces of silver in 1191.

Argenta district.—Shipments of ore produced from two deep mines, aggregating 35 tons, contained $13 in gold, 1,037 ounces of silver, and 9,769 pounds of copper, valued in all at $2,263, or an average per ton of $64.66. Some of the ore was from the Jack Rabbit claim and assayed as high as 15 per cent copper, with about 30 ounces of silver per ton.

Bannack district.—All of the ore produced by three deep mines, aggregating 632 tons, was shipped directly to the smelters and contained $77,086 in gold, 9,238 ounces of silver, 328 pounds of copper, and 7,870 pounds of lead, valued in all at $83,175, or an average value per ton of $131.60. Much of this ore was siliceous in character, containing considerable gold and small quantities of silver and lead, and was produced from the Excelsior, Wadams, and Golden Leaf claims. The Sulphide group of claims in the Bald Mountain region was also worked and produced lead sulphide ore with good values in silver and small quantities of gold and copper. Placer productions were reported from three sources, from which bullion was shipped containing $2,742 in gold and 13 ounces of silver.

Beaverhead or Bloody Dick district.—A small quantity of copper sulphide ore was produced from the Kelly group, a property 9 miles from Brenner.

Blue Wing district.—Ore shipped from the New Departure mine by lessees was siliceous in character and contained considerable silver and small quantities of copper and gold.

Bryant district.—Two deep mines yielded an important tonnage of copper-lead ore of shipping grade. The producing properties were the Trapper, Cleve, Franklin, Atlantis, and True Fissure, all of which have been consolidated under the Penobscot Mining Co. The entire production aggregated 949 tons.

Nogo district.—A small quantity of lead sulphide ore containing silver was shipped from the Millionaire property.

Polaris district.—Shipments of siliceous silver ore were made from the Polaris claims, and a small tonnage of similar ore was also shipped from neighboring claims.

Utopia district.—Two deep-mine producers, the Indian Queen and the Silver King properties, yielded copper and lead ore, which was shipped directly to the smelters.

BLAINE COUNTY.

Blaine County was established in 1912 and includes all mines that were formerly in Chouteau County. The output of 82,561 tons of ore produced by two operators in 1912 was 13,068 tons more than was mined by the same number of operators in the same district in 1911.

Little Rockies district.[1]—The Mint and Ruby Gulch properties were the only important producers, yielding siliceous gold ore, which was treated by the cyanide process. The shaft of the August mine was sunk about 100 feet, and 400 feet of drifting work was accomplished. The mill was not operated. According to the report of the company, it was expected that a new cyanide plant will be erected during 1913.

[1] Emmons, W. H., Gold Deposits of the Little Rocky Mountains, Montana: Bull. U. S. Geol. Survey No. 340, 1908, pp. 96–116.

BROADWATER COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Broadwater County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	39	27,722	$605,642	13,387	140,558	149,276	$637,024
1912	38	20,197	362,306	15,431	285,460	52,541	421,261
Increase (+) or decrease (−) in 1912 ...		−7,575	−243,336	+2,044	+144,902	−96,735	−215,763

[a] Includes placer production

The mine output of 20,197 tons of ore for 1912, produced by 32 producers, was 7,575 tons less than the output made by 27 producers in 1911. All of the ore, with the exception of 12 tons which produced bullion and concentrates, was shipped to the smelters and aggregated 20,185 tons, containing $355,013 in gold, 15,311 ounces of silver, 285,460 pounds of copper, and 52,541 pounds of lead, valued in all at $413,894, or an average value of $20.51 per ton. The larger part of the ore, aggregating 20,007 tons, was dry or siliceous in character, and the quantity of lead ore produced was 190 tons. The placer output made by 6 producers aggregated $3,771 in gold and 19 ounces of silver.

Backer or Diamond City district.—The Slim Jim property and its one-stamp mill were worked on siliceous ore, rich in gold, mined from small seams on the property.

Beaver district.—The output of 10 deep mines, the same number operating in 1911, aggregated 888 tons, containing $31,975 in gold, 5,453 ounces of silver, 1,097 pounds of copper, and 27,778 pounds of lead, valued in all at $36,759, or an average per ton of $41.40. The output in 1911 aggregated 2,954 tons, averaging $39.62 per ton. The Iron Age, Martha Washington, East Pacific, Cynosure, Mary V., and New York properties were the principal producers. The larger part of the ore shipments consisted of dry or siliceous ores.

Cedar Plains district.—Ore was produced from 8 deep mines aggregating 19,158 tons, containing $320,558 in gold, 8,666 ounces of silver, and 282,410 pounds of copper, valued in all at $372,486, or an average value per ton of $19.44. The bulk of the ore was from the Keating mine, which yielded iron pyrite carrying gold and some copper. Similar ore was produced from the Ohio Keating property. The Black Friday, Stevenson, and Keystone were also producers. The production from two placer properties amounted to $397 in gold and 2 ounces of silver.

It is reported that with the completion of the railroad, the output of the Keating mine will be increased from 50 to 250 tons per day. The ore averages about $20 per ton in gold and carries as high as 3½ per cent of copper and also iron, which is desirable with its sulphur at the smelter. The Keating mine shaft has reached a depth of 800 feet, and the gold values are reported to continue high.

Park district.—Thirteen deep mines produced 146 tons of ore, most of which was mixed oxidized and sulphide lead ores shipped directly

to the smelters. It contained $2,554 in gold, 1,192 ounces of silver, 1,953 pounds of copper, and 24,763 pounds of lead, valued in all at $4,723, or an average value per ton of $32.35. The Florence, Relief, Magpie, Last Chance, Marietta, and a number of prospects produced ore. The production from the Bowman Bar placers on Indian Creek and the Cedar Creek, Hassel, and Big W. placer properties amounted to $3,374 in gold and 17 ounces of silver.

CASCADE COUNTY.[1]

Mine production of gold, silver, copper, and lead, and number of producers in Cascade County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	10	2,962	$2,774	99,825	5,314	861,613	$95,118
1912	14	7,406	4,037	138,608	6,379	2,259,494	192,011
Increase (+) or decrease (−) in 1912		+4,444	+1,263	+38,783	+1,065	+1,397,881	+96,893

Production was reported from 14 mines in 1912, against 12 in 1911. The largest part of the ore was of shipping grade and aggregated 2,378 tons, containing $2,160 in gold, 73,857 ounces of silver, 703 pounds of copper, and 687,537 pounds of lead, valued in all at $78,637, or an average value per ton of $33.07. In addition to the crude smelting ore produced, there were 5,003 tons of ore milled, producing lead concentrates containing gold and silver and a little copper. At a gold and silver mill a small quantity of bullion was produced. The largest part of the output, or 6,252 tons, was lead ore, and the remainder, 1,154 tons, was dry or siliceous in character.

Montana district.—The production of ore from 14 deep mines aggregated 7,406 tons, containing $4,037 in gold, 138,608 ounces of silver, 6,397 pounds of copper, and 2,259,494 pounds of lead, valued in all at $192,011, or an average value per ton of $25.93. There were shipped directly to smelters 2,378 tons of crude ore and 2,001 tons of lead concentrates. The latter contained the bulk of the lead produced in the district. A small quantity of ore was treated at a gold and silver mill, producing bullion. All of the concentrated ore was produced from the Barker mines, and the ores of shipping grade were produced from the Alice & Hartley, Florence, Broadwater, Queen of the Hills, and Ripple properties.

CHOUTEAU COUNTY.

This county was divided in 1912 and the part in which the precious metal producers are situated is now Blaine County.

[1] Weed, W. H., Geology of the Little Belt Mountains, Montana, with notes on the mineral deposits of the Neihart, Barker, Yogo, and other districts: Twentieth Ann. Rept., U. S. Geol. Survey, pt. 3, 1900, pp. 271-461.

DEER LODGE COUNTY.

Reports from 8 deep-mine operators show the production of 1,814 tons of ore, which is 3,842 tons less than was produced by 13 producers in 1911. The total average value of the ore decreased from $18.93 in 1911 to $14.25 in 1912, and the gold and silver value in this ore from $18.76 to $14.25 per ton. A large part of the tonnage produced was of smelting grade, aggregating 1,002 tons, which contained $19,346 in gold, 390 ounces of silver, and 51 pounds of copper, valued in all at $19,594, or an average value per ton of $19.55. At gold and silver mills 812 tons of ore were treated, yielding $6,237 in gold and 44 ounces of silver. All of the ore produced in 1912 was dry or siliceous in character. Only one placer producer reported production.

Georgetown district.—All of the output reported by 8 deep-mine producers aggregated 1,814 tons, containing $25,583 in gold, 434 ounces of silver, and 51 pounds of copper, valued in all at $25,858, or an average per ton of $14.25. Most of the product shipped was oxidized iron ore and aggregated 1,002 tons, the bulk of it coming from the Holdfast and Oro Fino properties. Lessees operated the Gold Coin property and its 20-stamp amalgamation mill, which was closed when the ore became of too low grade for profitable milling. The purchase of the Southern Cross property by the Anaconda Copper Mining Co. and the completion of the 18-mile extension of the Butte, Anaconda & Pacific Railroad through Warm Springs Canyon to the mine have greatly stimulated the development of adjacent properties. The Southern Cross ore carries a fair amount of gold and contains 20 per cent excess iron.

Heber district.—Lessees worked the French Gulch placers and produced a small amount of gold from sluicing operations.

FERGUS COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Fergus County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1911	7	98,546	$358,581	8,676	.....	17,446	75,995	$368,296
1912	10	68,726	441,082	11,058	274	11,863	15,301	449,518
Increase (+) or decrease (−) in 1912		−29,820	+82,501	+2,382	+274	−5,583	−60,694	+81,222

[a] Includes placer production.

The production of 68,726 tons of ore was reported from 9 properties in 1912, which was 3 less in the number of producers and 29,820 tons less in the quantity of ore than in 1911. The total average value of the ore increased from $3.74 to $6.54 in 1912, and the gold and silver value of this ore from $3.68 to $6.52 per ton. The greater part of the tonnage, aggregating 68,145 tons, was treated by the cyanidation process. Crude ore was shipped to the smelters amounting to 581 tons. All of the ore produced was siliceous in character,

with the exception of 15 tons of lead ore and 27 tons of zinc ore. One placer producer reported production.

North Moccasin district.—Ore was produced from the Kendall and Barnes King properties. The Kendall mine and mill were closed in November after continuous operations since 1901. The old property belonging to the Barnes King Co. has been abandoned and work was started to open the North Moccasin mine, adjoining, on September 1. The Barnes King mill began the treatment of the North Moccasin ore in December. The output of the district was practically that of one mine and consisted of gold and silver bullion extracted by the cyanide process.

Warm Springs district.—Through the failure of several operators to report, the district production is partly estimated. The total output of the district amounted to $348,027, the bulk of which came from the operations of cyanide plants. The value includes the shipment of siliceous ore, lead ore, and zinc ore directly to the smelters. Properties reported operating were the Maginnis, War Eagle, Cumberland, Gold Reef, and New Year mines.

GALLATIN COUNTY.

West Gallatin or Spring Hill district.—A small production of gold was reported from the West Fork of West Gallatin River, recovered from stream gravels by sluicing operations.

GRANITE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Granite County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	39	9,357	$139,440	350,852	16,627	80,679	$331,100
1912	38	10,798	105,376	414,831	166,312	89,597	391,971
Increase (+) or decrease (−) in 1912		+1,441	−34,064	+63,979	+149,685	+8,918	+60,871

[a] Includes placer production.

Thirty-three producers reported the production of 10,798 tons of ore, which was 1,441 tons more than was produced by 32 producers in 1911. The total average value per ton of the ore increased from $35.11 in 1911 to $36.08 in 1912, and the gold and silver value decreased from $34.50 to $33.17 per ton. Nearly all of the ore was of shipping grade and aggregated 8,846 tons, containing gold, silver, copper, and lead, valued at $376,989, or an average value per ton of $42.62. Only 25 tons were reported as having been treated at gold and silver mills, producing bullion valued at $9,856. Five placer producers reported the output of $2,317 in gold and 14 ounces of silver.

The geography, geology, and mineralogy of the region adjacent to Philipsburg, Mont., is described in a paper [1] published by the Survey.

[1] Emmons, W. H., and Calkins, F. C., Geology and ore deposits of the Philipsburg quadrangle, Montana: Prof. Paper No. 78, 1913, 271 pp.

Alps district.—An amalgamation mill with from 3 to 5 tons capacity was completed and operated on ores from the Rainy Day property during part of December and produced a small amount of gold bullion.

First Chance district.—Eight deep mines yielded 810 tons of ore, containing $69,649 in gold, 3,704 ounces of silver, and 7,718 pounds of copper, valued in all at $73,201, or an average value per ton of $90.37. The bulk of the ore was from the Magone and Anderson property, and small tonnages were produced from the International, Nancy Hanks, Free Coinage, and Shamrock properties. Production of placer gold was reported from one source, in Fealand Gulch, 4 miles from Bearmouth.

Flint Creek district.—The largest production of the district came from the Granite Mountain mine, from the shipment of ores and the treatment of old tailings. The Hope mine was also productive of some ore of shipping grade. All together, there were 17 deep mines reported producing, with an output of 7,106 tons, which contained $23,024 in gold, 407,600 ounces of silver, 31,004 pounds of copper, and 83,186 pounds of lead, valued in all at $282,558, or an average value per ton of $39.76. A new cyanide plant was erected and put in operation near the Granite-Bimetallic mill to treat the old tailings.

Red Lion district.—The Hidden Lake mine was the principal producer and yielded oxidized iron ore, containing gold and silver. The mine was worked continuously during 1912 and the shipments of ore were made to Anaconda.

Rock Creek district.—The large placer mines in the district were not operated, and only small productions were reported.

South Boulder district.—The largest operations in the district were carried on at the Royal Basin property and the North Star mine, from which copper ores were produced and treated by the sulphuric acid leaching process and the copper was precipitated electrolytically. The first shipment of refined copper was made in January, 1913, but during 1912 a number of shipments of crude ore and copper precipitates were made in testing values. The Sunday group produced siliceous gold ore, which was treated in a cyanide plant. A small quantity of sulphide copper ore was shipped from the Free Silver property. The value of the output of the district amounted to $26,735, of which $1,051 in gold and silver was reported from placers.

JEFFERSON COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Jefferson County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1911	92	69,614	$96,094	823,704	161,719	2,088,236	.....	$646,843
1912	63	42,313	175,361	510,509	776,072	1,589,588	55,542	692,739
Increase (+) or decrease (−) in 1912		−27,301	+79,267	−313,195	+614,353	−498,648	+55,542	+45,896

[a] Includes placer production.

From 53 deep mines a production was reported of 42,313 tons of ore, which is 27,301 tons less than was reported from 76 mines in 1911. The total average value in 1911 was $9.23 per ton, increasing to $16.32 in 1912, and the gold and silver value increased from $7.59 to $11.51 per ton. The larger part of the ore produced, or 32,713 tons, was of smelting grade, containing $170,828 in gold, 450,075 ounces of silver, 773,597 pounds of copper, 1,487,165 pounds of lead, and 55,542 pounds of zinc, valued in all at $646,022, or an average value of $19.75 per ton. The output of milling ore aggregated 9,600 tons, producing 644 tons of concentrates, which contained $2,408 in gold, 60,416 ounces of silver, 2,475 pounds of copper, and 102,423 pounds of lead, valued in all at $44,581, or an average value of $69.22 per ton. Dry or siliceous ore predominated and amounted to 33,601 tons. There were also produced 4,477 tons of copper ore, 4,144 tons of lead ore, and 91 tons of lead-zinc ore. The placer production, amounting to $2,125 in gold and 18 ounces of silver, was reported by 10 producers.

Amazon district.[1]—The ore produced in the district aggregated 366 tons, having a total value of $6,631 for the gold, silver, lead, and copper content.

Boulder district.[1]—Five deep mines yielded 2,756 tons of ore, containing $8,723 in gold, 40,618 ounces of silver, 79,722 pounds of copper, and 234,114 pounds of lead, valued in all at $57,392, or an average value per ton of $20.82. Five placer producers yielded $573 in gold and 5 ounces of silver.

Cataract district (including Lowland).[1]—Ten deep-mine producers shipped 2,585 tons of ore to the smelters, containing $17,945 in gold, 46,975 ounces of silver, 62,012 pounds of copper, and 282,452 pounds of lead, valued in all at $69,777, or an average value per ton of $26.99. The total production in 1911 aggregated 2,052 tons, averaging $16.31 per ton. The Comet, Crystal, and Bullion properties, controlled by one operator, were the largest producers of ore. Most of the ore in the district will be treated at the Northwestern Metal Co.'s plant near Helena when it is completed. It is expected to recover all the metals now paid for by the smelters, including zinc, which will be recovered at that plant in the form of oxide. The Ruby and Columbia mines produced siliceous gold-silver ore of shipping grade. Placer productions from two sources yielded $697 in gold and 6 ounces of silver.

Colorado district.[1]—Operators of 7 deep mines produced ore of shipping grade, aggregating 5,600 tons, containing $8,751 in gold, 87,318 ounces of silver, 313,031 pounds of copper, 406,806 pounds of lead, and 55,542 pounds of zinc, valued in all at $136,240, or an average value per ton of $24.33. The principal producers were the Bertha, Dailey, Blue Bird, and Alta-Gregory. In 1913 it is expected the Boston-Corbin concentrating mill will be completed to treat the Bertha ores.

Elkhorn district.[2]—Ores were produced from 8 deep mines, aggregating 28,863 tons, which contained $88,506 in gold, 305,322 ounces of silver, 298,214 pounds of copper, and 493,414 pounds of lead,

[1] Knopf, Adolph, Ore deposits of the Helena mining region, Montana. Bull. U. S. Geol. Survey, No. 527, 1913.

[2] Stone, R. W., Geologic relation of ore deposits in the Elkhorn Mountains, Montana: Bull. U. S. Geol. Survey No. 470, 1911, pp. 75–98. Weed, W. H., and Barrell, Joseph, Geology and ore deposits of the Elkhorn mining district, Jefferson County, Mont.: Twenty-second Ann. Rept., U. S. Geol. Survey, pt. 2, 1902, pp. 399–550.

valued in all at $347,688, or an average value per ton of $12.05. The bulk of this output was oxidized iron ore, containing small quantities of gold, silver, and copper, sold to the smelters for flux. The Holter 20-stamp concentration mill was operated on sulphide ores, from which concentrates were produced, containing silver and lead and small quantities of gold and copper. The mine and mill were closed indefinitely the last of 1912.

Homestake district.—The output of ore, which aggregated 107 tons in 1911, decreased to 58 tons in 1912, valued at $4,171, or an average value per ton of $71.91. The principal metal content of the ore was silver.

Lump Gulch district.[1]—Seven mines yielded an output of 1,662 tons of shipping ore, containing $37,638 in gold, 19,939 ounces of silver, 16,382 pounds of copper, and 33,315 pounds of lead, valued in all at $54,102, or an average value per ton of $32.55. The output in 1911 of 175 tons amounted in total value to $2,947, and averaged $16.84 per ton. The largest part of the production came from the Carbonate Chief, Bell, and King Solomon properties.

McClellan Creek district.—For 30 days in 1912 the Hay Stack placer was operated, producing a small amount of gold, which averaged 0.854 in fineness.

Mitchell Gulch district.—Three deep mines and 2 placers reported a production valued at $5,309. The most important ore developments were made on the Dobler mine, which is situated 6 miles east of East Helena, near Louisville, on the Northern Pacific Railway. The ores produced at this mine in 1912 contained lead with considerable values in gold and silver. The property is worked by an incline shaft 350 feet deep. Mining operations were begun in October.

Whitehall district.—There were 230 tons of ore produced from 7 properties in 1912, all of which was of shipping grade and contained $6,634 in gold, 1,138 ounces of silver, 1,874 pounds of copper, and 44,416 pounds of lead, valued in all at $9,643, or an average of $41.93 per ton. The principal producers were the Columbia and the Kronholm

LEWIS AND CLARK COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Lewis and Clark County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	36	.....	$26,728	179	.....	.....	$26,823
1912	37	.....	48,204	431	.....	.....	48,469
DEEP MINES.							
1911	43	43,850	231,757	57,404	7,402	116,146	268,333
1912	52	36,843	197,695	44,706	17,075	120,994	233,451
Increase (+) or decrease (−) in 1912		−7,007	−12,586	−12,446	+9,673	+4,848	−13,236

Production of ore was reported from 52 deep mines, aggregating 36,843 tons, which was 7,007 tons less than was produced by 43 producers in 1911. The total average value of the ore was slightly

[1] Knopf, Adolph, op. cit.

increased from $6.12 in 1911 to $6.34 in 1912, and the gold and silver value per ton increased from $5.98 to $6.11. The greater part of the ore mined was treated at gold and silver mills by the amalgamation and cyanidation processes. Altogether there were 30,957 tons of ore treated, producing bullion and cyanide precipitates containing $181,273 in gold and 17,834 ounces of silver, with a total value of $192,241. Some concentrates were produced at these milling plants in addition to the bullion, and only 57 tons of ore were directly concentrated. The shipments of concentrate amounted to 136 tons, containing gold, silver, copper, and lead, valued at $10,004, or an average value per ton of $73.56. The crude ore shipped directly to smelters, aggregating 1,020 tons, contained $9,951 in gold, 23,036 ounces of silver, 13,788 pounds of copper, and 106,956 pounds of lead, valued in all at $31,206, or an average value per ton of $30.59. There were only three kinds of ore produced, dry or siliceous ore, which aggregated 36,163 tons, 98 tons of copper ore, and 582 tons of lead ore. The placer output reported by 37 producers amounted to $48,204 in gold and 431 ounces of silver.

Bald Butte district.[1]—Ore containing principally gold, silver, copper, and lead values was amalgamated and concentrated in the 40-stamp mill on the Bald Butte property, and gold and silver bullion and lead sulphide concentrates were produced.

Dry Gulch district.—There was produced from two properties gold ore containing some silver, which averaged $82.38 per ton. Ten placers in the district produced $36,679 in gold bullion. Placer operations were carried on in Magpie Gulch, where a dredge was in operation for nine months. The fineness of the gold produced averaged about 0.870.

Gould district.—Ore was produced from the Hubbard mine, carrying gold and silver, which was contained in bullion and concentrates produced. The Gould mine was also a producer of gold bullion by the amalgamation and cyanidation process.

Greenhorn district.—Production was reported from 2 deep mines and 2 placers amounting to $1,069. The Umatilla mine and the Greenhorn and the Jones Stevens placers were producers.

Heddleston district.—Lead concentrates were shipped from the Anaconda property from ore treated in a 2-ton hand jig. The output contained gold, silver, and copper.

Helena district.[1]—This region is described in a paper by Knopf, recently published by the Survey. The total production in 1912 amounted to 146 tons of ore, containing gold, silver, copper, and lead, from deep mines, valued at $3,455, and $1,574 in gold, and 11 ounces of silver from placers. The bulk of the ore was shipped directly to the smelters, and only a small tonnage was treated in an amalgamation mill.

Jefferson Gulch district.—Milling operations were carried on at the Mutual property, which is situated 6 miles north of Finn. The mill product consisted of bullion and a small quantity of concentrates produced from a 10-stamp amalgamation and concentration mill on the property.

Lincoln district.—Seven placer properties produced $2,883 in gold and 20 ounces of silver in 1912.

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[1] Knopf, Adolph, op. cit.

Ottawa district.[1]—In the vicinity of Marysville the output of 13 deep mines and 1 placer aggregated $139,396 in value in 1912. There were 27,650 tons of ore produced, which contained $126,040 in gold, 20,664 ounces of silver, and 5,854 pounds of lead. The average recovery value of this ore amounted to $5.03 per ton. The bulk of the output was recovered by the amalgamation and cyanidation processes, one mill being equipped with concentration tables, which recovered a small quantity of iron concentrates containing gold and silver. The crude ore shipped directly to smelters contained lead besides gold and silver and amounted to 119 tons. The largest ore producers were the Cruse mines, on which the cyanide and amalgamation plant was operated. On the St. Louis property a 100-ton cyanide plant was constructed. Most of the production of 1912 consisted of concentrates and bullion containing gold and silver. An important tonnage of Canyon Creek tailings were treated by the cyanide process. The Piegan-Gloster mine, an old producer, was sold to the Barnes King Co., which operates mines in Fergus County.

Seven Mile district.—An oxidized lead ore, containing gold and silver, was produced from the Saginaw and Montezuma properties, which were worked by lessees.

Stemple district.—One deep mine and 2 placers produced ore and bullion having a total value of $987.

Springhill and Unionville district.[2]—The output of 3 deep mines and 1 placer, the same number reporting in 1911, amounted to $4,046 in gold, 176 ounces of silver, 600 pounds of copper, and 255 pounds of lead. The total output was valued at $4,265, against an output valued at $3,784 in 1911. A small quantity of ore was produced from the Whitlatch property by a lessee.

Vaughn district.[2]—Three deep mines and 4 placers yielded an output valued at $15,365. The ore shipped aggregated 350 tons, containing $1,753 in gold, 6,079 ounces of silver, 864 pounds of copper, and 81,333 pounds of lead, valued in all at $9,294, or an average value per ton of $26.55. The placer production amounted to $5,972 in gold and 160 ounces of silver. The principal deep mine producers were the Lee Mountain and Valley Forge properties, and the placers were the Dynamite, Perseverance, Tucker Gulch, and Last Dollar.

LINCOLN COUNTY.

The output of 4 deep mines and 3 placers amounted in total value to $84,744. The same number of operators reported production in 1911. Ore mined aggregated 8,719 tons, which was 4,477 tons more than reported in 1911. The total value per ton decreased from $10.75 in 1911 to $9.16 in 1912, and the gold and silver value of this ore increased from $2.84 to $2.99 per ton. Nearly all of the ore produced was of milling grade, yielding concentrates which contained gold, silver, and lead. Only 41 tons of ore were treated at a gold and silver mill, yielding gold and silver bullion. A small tonnage of zinc sulphide ore was shipped directly to the smelters. The production of gold and silver reported by 3 placer producers amounted to $4,859 in gold and 15 ounces of silver.

[1] Barrell, Joseph, Geology of the Marysville mining district, Montana: Prof. Paper, U. S. Geol. Survey, No. 57, 1907, 178 pp. Weed, W. H., Gold mines of the Marysville district, Montana: Bull. U. S. Geol. Survey No. 213, 1903, pp. 88-89. Knopf, Adolph, op. cit.

[2] Knopf, Adolph, op. cit.

Callahan Creek district.—A small production of zinc sulphide ore was made from the Big Eight property, near Troy. The average content in zinc was from 46 to 52 per cent without gold or silver values. A paper [1] by Calkins and MacDonald describing much of the geology of this and adjoining districts has been published by the Survey.

Libby district.—A large part of the ore produced in the district was concentrated, and the concentrates were shipped to the smelters. A small tonnage treated at an amalgamation mill produced gold bullion. The total output of placers and deep mines was valued at $80,915 for the gold, silver, and lead. The largest production of ore of concentrating grade was from the Snowshoe mine, and the ore amalgamated was from the Annie mine, at which a 3-stamp mill was erected, in the West Fisher district, 35 miles south of Libby.

MADISON COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Madison County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	17	.....	$584,948	4,516	.....	.....	$587,341
1912	12	.....	689,197	5,094	.....	.....	692,330
DEEP MINES.							
1911	111	28,765	275,441	97,841	25,533	225,416	340,633
1912	103	21,689	163,397	40,378	19,840	152,328	198,359
Total increase (+) or decrease (−) in 1912		−7,076	−7,795	−56,885	−5,693	−73,088	−37,285

The ore from 103 producers in 1912 amounted to 21,689 tons, which is 7,076 tons less than was produced by 111 producers in 1911. The total average value of the ore decreased from $11.84 in 1911 to $9.14 in 1912 and the gold and silver value of this ore from $11.38 to $8.68 per ton. The greater part of the ore was treated at gold and silver mills and aggregated 18,890 tons, producing bullion, which contained $38,311 in gold and 4,779 ounces of silver. In addition, there were 770 tons of concentrates produced at these mills, containing $38,630 in gold, 9,561 ounces of silver, and 4,353 pounds of copper, valued in all at $45,228, or an average value of $58.76 per ton. The crude ores shipped directly to smelters aggregated 2,799 tons, containing $86,456 in gold, 26,038 ounces of silver, 15,487 pounds of copper, and 152,328 pounds of lead, valued in all at $111,879, or an average value of $39.97 per ton. Nearly all of the ore (21,328 tons) was dry or siliceous in character. There were also produced 350 tons of lead ore and 11 tons of copper ore. Gold and silver bullion produced by 12 placer producers amounted to $689,197 in gold and 5,094 ounces of silver, having a total value of $692,330.

Alder Gulch district.—Twenty-two deep mines in 1912, against 14 in 1911, produced 674 tons of ore, containing $12,856 in gold, 9,287 ounces of silver, 1,330 pounds of copper, and 24,480 pounds of lead,

[1] Calkins, F. C., and MacDonald, D. F., A geologic reconnaissance in northern Idaho and northwestern Montana: Bull. U. S. Geol. Survey No. 384, 1909, 112 pp.

valued in all at $19,889, or an average value per ton of $29.51. The bulk of the ore (386 tons), which contained the copper and lead, was shipped directly to the smelters, and 288 tons were milled, producing gold and silver bullion. The placers yielded the largest part of the total output, and produced $687,863 in gold and 5,084 ounces of silver. The output was reported by 9 producers. The placer production in 1911 was $582,055 in gold and 4,492 ounces of silver, reported by 8 operators. The principal placer operations were carried on by the Conrey Placer Mining Co., at Ruby. This company has under control a large area of ground reaching from a short distance below Virginia City to and below Ruby.

Bone Basin district.—Iron sulphide ore of shipping grade was produced from the Bonanza Fraction property and contained gold, silver, and copper.

Lower Hot Springs district.—Ten deep-mine producers shipped 94 tons of ore, containing $3,726 in gold, 243 ounces of silver, 624 pounds of copper, and 281 pounds of lead, valued in all at $3,995, or an average value per ton of $42.50. The May Queen, Birdie, Josephine, Red Bluff, and Morning Star were the principal producers.

Mineral Hill district.—The larger part of the 14,173 tons of ore mined was treated at amalgamation and concentration plants, producing bullion and concentrates, and 170 tons of ore were shipped directly to the smelter, containing principally gold and small quantities of silver and lead. The principal producer was the Boss Tweed & Clipper property, which, with its 15-stamp amalgamation and concentration mill, was operated the entire year.

Norwegian district.—Gold and silver ore was shipped directly to the smelters from the Gold Hill and Mayflower properties, having a total value of $4,209.

Rabbit district.—Five deep mines yielded 267 tons of ore, containing $2,221 in gold, 5,127 ounces of silver, 664 pounds of copper, and 79,783 pounds of lead, valued in all at $9,074, or an average value per ton of $33.99. The ore output was reported from the Emma, Mount Rose, Polly Jane, Cooper, and Watseca properties.

Ramshorn district.—In the vicinity of Laurin, the Drew, Betsy Baker, Gold Coin, Harris, and California Gulch properties produced $1,678 in gold and 250 ounces of silver, valued in all at $1,832, against an output of $3,242 in gold and 265 ounces of silver in 1911.

Sheridan district.—Seven deep mines produced 193 tons of shipping grade ore, containing values principally in gold with some copper and lead, and 100 tons of ore which was treated at an amalgamation mill. The ore mined contained $7,256 in gold, 2,154 ounces of silver, 4,596 pounds of copper, and 1,764 pounds of lead. The total output, including that from one placer property, was valued at $9,702.

Silver Star district.—From the operations of 10 deep mines, the same number working in 1911, there was a production of 2,891 tons of ore, containing $26,298 in gold, 1,012 ounces of silver, 1,859 pounds of copper, and 2,554 pounds of lead, valued in all at $27,343, or an average value per ton of $9.46. The bulk of the ore was treated in the cyanide mill at the Hudson mine, and 367 tons of crude ore were shipped directly to the smelter. The principal shipments of ore were made from the Broadway, Edgerton, Gunderson, Keystone, and Sage Hen properties.

Summit district.—Ten deep-mine producers reported the production of 2,219 tons of ore, of which 1,745 tons were of milling grade, yielding

bullion and concentrates, and 474 tons were crude ores shipped directly to the smelters. The total value of the district output amounted to $34,772, or an average value of $15.67 per ton. Milling and smelting ore was produced from the Bell property, which is equipped with a 40-ton stamp mill with vanners and a cyanide plant. The Easton Pacific mine, which has been the largest producer of gold and silver in recent years, was under development, but no ore was shipped in 1912. Other producers were the Elfleda, Mountain Flower, Mountain Chief, and Mapleton.

Tidal Wave district.—Production of ore was reported from 23 sources and aggregated 242 tons, containing $7,840 in gold, 2,600 ounces of silver, 3,673 pounds of copper, and 42,573 pounds of lead, valued in all at $11,961, or an average value per ton of $49.43. All of the ore produced was of shipping grade. The principal shipments of ore were made from the Ajax, Keynote, Ella, Carolina, Mountain View, and Texas properties.

Upper Hot Springs district.—The Monitor and Revenue property yielded gold and silver from the treatment of ore by the cyanide process, and a shipment of crude ore was made directly to the smelters.

Washington Gulch district.—Three producers yielded 130 tons of ore, containing $9,004 in gold, 1,103 ounces of silver, 201 pounds of copper, and 620 pounds of lead, valued in all at $9,743, or an average value per ton of $74.95. All of this product was of shipping grade and was produced from the George McKee, Lehigh, and Missouri properties.

MEAGHER COUNTY.

Two deep-mine operators reported the production of 33 tons of ore, which is 34 tons less than was produced by 3 operators in 1911. The total average value of the ore increased from $30.75 in 1911 to $39.66 in 1912, and the gold and silver value in this ore from $2.06 to $19.06 per ton. All of the ore produced was classed as lead ore, containing gold, silver, copper, and lead, and was shipped directly to the smelter. Bullion from 4 placers amounted to $494 in gold and 2 ounces of silver.

Musselshell district.—The output of 1 deep mine and 2 placers amounted in value to $628.

MISSOULA COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Missoula County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	29	.....	$20,395	52	.....	.....	$20,422
1912	26	.....	17,479	44	.....	.....	17,506
DEEP MINES.							
1911	3	4,527	14,500	2,536	.....	28,979	17,149
1912	6	2,362	8,260	648	10,710	5,337	10,666
Total increase (+) or decrease (−) in 1912	.....	−2,165	−9,156	−1,896	+10,710	−23,642	−9,399

Six deep-mine operators reported the output of 2,362 tons of ore, which is 2,165 tons less than was reported by 3 producers in 1911. The total average value of the ore increased from $3.79 in 1911 to $4.51 in 1912, and the gold and silver contained in the ore from $3.50 to $3.66 per ton. Nearly all of the ore, or 2,225 tons, was of milling grade and was treated by the amalgamation process, producing bullion containing $8,223 in gold and 16 ounces of silver. The crude smelting ore shipped aggregated 137 tons, containing mostly copper with some lead and small amounts of gold and silver. All of the ore producing bullion was dry or siliceous in character, and of the smelting ore shipped, 121 tons were copper and 16 tons were lead ore. The production of bullion from 26 placer producers amounted to $17,479 in gold and 44 ounces of silver.

Cedar, Quartz, and Trout Creek district.—All of the 1912 production of this district came from placer mining, reported from 21 sources, amounting to $14,129 in gold and 32 ounces of silver. In 1911 the yield from 22 placer mines was $16,632 in gold and 48 ounces of silver. The most important production came from the property of the Cedar Creek Dredging Co., operating the Kansas City dredge, which was reported closed down in July. Other properties producing were the Deep Gulch, California, Meadow Creek, Ohio Gulch, Stockholm, Sunrise, C. B. and Q., and Windfall mines.

Ninemile district.—The production of this district by 2 deep mines and 5 placers aggregated in total value $11,590. There were produced 2,255 tons of ore, which was milled, yielding gold bullion by the amalgamation process, from the Provisional and San Martina properties. The placers operated were the Tom Thumb, Slide, and Chrysalis properties. A paper[1] describing much of the geology of the district has been published by the Survey.

PARK COUNTY.

The production of 179 tons of ore by 6 producers in 1912, which was 121 tons more than was reported by 3 producers in 1911, aggregated $1,951 for the gold and silver content. There were 4 placer producers reporting $717 in gold and 6 ounces of silver. All of the ore produced in the county was dry or siliceous in character, and 171 tons were milled, producing bullion.

Emigrant Creek district.—From 4 placers in the district there was produced $717 in gold and 6 ounces of silver. The principal operations were performed by the Chico Mining Co., which owns claims for 5 miles along Emigrant Creek. This company operated with a steam shovel.

Natural Bridge district.—The 5-stamp mill of the Drago mine, the post office of which is at Contact, was operated long enough on ore produced to make a test by the amalgamation process.

[1] Schrader, F. C., Gold-bearing ground moraine in northwestern Montana: Bull. U. S. Geol. Survey No. 470, 1911, pp. 62–74.

POWELL COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Powell County, Mont., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	28	.....	$23,343	163	.....	.....	$23,429
1912	25	.....	26,706	168	.....	.....	26,809
DEEP MINES.							
1911	19	2,536	36,772	25,496	41,468	110,796	60,454
1912	20	1,957	24,585	43,936	96,369	42,456	69,417
Total increase (+) or decrease (−) in 1912		−579	−8,824	+18,445	+54,901	−68,340	+12,343

Twenty deep-mine producers reported the output of 1,957 tons of ore, which was 579 tons less than was reported by 19 producers in 1911. The total average value of the ore increased from $23.84 in 1911 to $35.47 in 1912, and the gold and silver value in this ore from $19.83 to $26.37 per ton. Nearly all of the ore produced was of smelting grade, aggregating 1,786 tons, which contained $23,558 in gold, 43,856 ounces of silver, 96,369 pounds of copper, and 42,456 pounds of lead, valued in all at $68,342, or an average value per ton of $38.27. At milling plants, 171 tons of ore were treated, producing bullion containing $1,027 in gold and 80 ounces of silver. Of the ore produced, the largest part, or 1,189 tons, was classed as copper ore, 527 tons as siliceous ore, 152 tons as lead ore, and 89 tons as copper-lead ore. The placer output of $26,706 in gold and 168 ounces of silver was reported by 25 producers.

Big Blackfoot district.—Through the operations of 1 deep mine and 2 placers, $1,310 in gold and silver was produced.

Bear Gulch district.—The Elk Creek, Warren's, and Alabama placers, the latter situated on the summit between Bear Gulch and Elk Creek Gulch, produced gold bullion.

Coloma district.—Three deep mines and 1 placer property yielded an output valued at $4,948. Altogether there were 125 tons of ore mined, which contained $3,034 in gold, 87 ounces of silver, and 5,156 pounds of copper, averaging in value per ton $31.51. The Dandy mine was the largest producer.

Ontario district.[1]—Operators of 3 deep mines reported the production of 83 tons of ore, containing $1,160 in gold, 1,298 ounces of silver, 5,435 pounds of copper, and 3,291 pounds of lead, valued in all at $3,002, or an average value per ton of $36.17. All of the ore was of shipping grade.

Ophir district.[1]—From the operations of 10 deep mines 1,588 tons of ore were produced. Most of the ore, or 1,430 tons, was shipped directly to the smelters and contained 832.02 ounces of gold, 38,210 ounces of silver, 81,490 pounds of copper, and 24,123 pounds of lead. At gold and silver mills 158 tons of ore were treated, producing gold and silver bullion. The largest producer was the Julia property, near Elliston. The placer production amounted to $1,685 in gold

[1] Knopf, Adolph, op. cit.

and 6 ounces of silver, against a production of $2,475 in gold and 8 ounces of silver in 1911.

Pioneer district.—Five placers yielded $21,436 in gold and 141 ounces of silver, against a production of $18,038 in gold and 143 ounces of silver from 7 placer producers in 1911. The output of 1 deep mine averaged $19.46 per ton in silver and lead.

Washington Gulch district.—Through the operations of 6 placers $885 in gold and 6 ounces of silver were produced, against a production of $2,591 in gold and 29 ounces of silver in 1911. None of the deep mine operators reported production.

Zozell district.—Two deep mine producers reported the output of 143 tons of ore, all of which was shipped directly to the smelters, and averaged in gold, silver, copper, and lead $42.47 per ton. The Blue Bell and Blue Eyed Maggie properties were operated.

RAVALLI COUNTY.

The reports of 2 producers show a production of 54 tons of ore, which is 171 tons less than was produced by 1 operator in 1911. The total average value of the ore decreased from $14.83 in 1911 to $9.16 in 1912, but the gold and silver value in this ore increased from $6.03 to $9.16 per ton. All of the ore mined was dry or siliceous in character, and part of it was treated in a milling plant, producing gold and silver bullion, and 29 tons were shipped directly to the smelters. The placer production amounted to $5,857 in gold and 17 ounces of silver reported by 4 producers.

Hughes Creek district.—Four placer producers reported a production of $5,857 in gold and 17 ounces of silver.

SANDERS COUNTY.

Through the operations of 4 deep mines 791 tons of ore were produced, which is 655 tons more than was produced from 3 deep mines in 1911. The total average value per ton increased from $26.15 in 1911 to $26.98 in 1912, and the gold and silver value in the ore from $5.07 to $8.06 per ton. All of the ore produced was shipped directly to the smelters and included 750 tons of copper-lead ore, 26 tons of copper ore, and 15 tons of lead ore. The total value of the ore amounted to $21,341, or an average value per ton of $26.98.

Perma district.—The Glancus property was a producer of lead sulphide ore, containing a small quantity of silver and copper.

Spring Gulch district.—Shipping ore was produced from 3 properties aggregating 788 tons, which contained $572 in gold, 9,353 ounces of silver, 52,167 pounds of copper, and 138,110 pounds of lead, valued in all at $21,146, or an average per ton of $26.84. The principal producer was the King and Queen group, which was operated during the latter part of the year. The mine is being equipped with a 50-ton concentrating mill, which was under construction the early part of 1913.

SILVER BOW COUNTY.

Tons of ore sold or treated in Silver Bow County, Mont., in 1904–1912, number of producers, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	37	4,102,604	$971,046	10,530,582	290,032,979	.....	.....	$44,187,679
1905	61	4,419,300	1,266,175	11,191,016	304,307,893	1,140,666	1,560,000	55,643,230
1906	62	5,019,234	1,250,563	10,715,721	289,780,050	895,566	6,579,000	64,810,013
1907	82	3,735,346	710,441	7,516,659	218,836,627	223,676	243,100	49,464,959
1908	107	3,858,058	661,619	8,500,729	250,150,712	597,819	1,640,000	38,289,087
1909	80	5,000,062	815,368	10,609,328	311,323,650	199,056	9,299,154	47,315,005
1910	90	4,709,429	765,155	10,400,840	284,264,862	350,173	31,620,184	44,206,144
1911	73	4,569,942	731,905	10,258,122	272,271,171	1,017,273	43,734,150	42,741,229
1912	94	5,243,935	794,643	11,352,106	308,222,547	1,296,283	26,792,550	60,539,927
Increase (+) or decrease (−) in 1912		+673,993	+62,738	+1,093,984	+35,951,376	+279,010	−17,002,294	+17,798,698

[a] Includes placer production.

Operators of deep mines increased from 63 in 1911 to 86 in 1912. The increase is due largely to the extra number of lessees who found it profitable to mine and ship the ore with the higher prices paid for metals. There were 5,243,935 tons of ore produced, which is 673,993 tons more than was mined in 1911, and the total average value per ton increased, principally on account of copper, from $9.35 in 1911 to $11.54 in 1912, but the average gold and silver value in this ore remained nearly the same, increasing only from $1.35 to $1.48 per ton. The value of the gold produced from deep mines and placers amounted to $794,643 in 1912, as against $731,905 in 1911, and the silver output, valued at $5,436,805 in 1911, increased to $6,981,545 in 1912; the copper production increased in value from $34,033,896 in 1911 to $50,856,720 in 1912; the lead, from $45,777 in 1911 to $58,333 in 1912; and the zinc decreased from $2,492,846 to $1,848,686. In total value the entire output increased from $42,741,229 to $60,539,927. Most of the ore mined, or 4,473,970 tons, was treated at the concentration mills at Butte, Anaconda, and Great Falls, producing copper concentrates and some zinc concentrates, aggregating 1,529,423 tons, containing $558,003 in gold, 8,437,055 ounces of silver, 218,692,721 pounds of copper, 1,235,566 pounds of lead, and 26,792,550 pounds of zinc, valued in all at $43,735,377, or an average value per ton of $28.60. The crude smelting ores treated at smelters aggregated 765,220 tons, and contained $227,087 in gold, 2,895,255 ounces of silver, 83,195,908 pounds of copper, and 60,717 pounds of lead, valued in all at $15,737,726, or an average value per ton of $20.57. The production was classified as 5,086,913 tons of copper ore, 136,457 tons of zinc ore, 20,413 tons of dry or siliceous ore, and 152 tons of lead ore. Placers operated in the county produced $1,407 in gold and 7 ounces of silver.

Divide Creek district.—Nearly all of the 1,466 tons of ore mined in the district was milled, producing gold bullion principally from cyanide operations, and 166 tons of ore were shipped directly to the smelters, yielding gold, silver, and copper. There were 8 deep mines and 3 placers producing, and the output of the district contained

$6,629 in gold, 2,442 ounces of silver, and 18,887 pounds of copper, valued in all at $11,247. There was recovered from the ore milled an average of $7.55 in gold and silver per ton. The ore treated by the cyanide process came principally from the Gold Hill mine. Its mill was operated intermittently during the last six months of the year. Shipping ore was produced principally from the Gold King, Copper Bell, High Ridge, and Combination properties.

German Gulch district.—Small quantities of gold from this district were reported by purchasers of the product. The total output in 1912 aggregated $641 in gold and 3 ounces of silver, as against a production estimated at $4,579 in gold and 66 ounces of silver in 1911.

Highland district.—Four deep mines and 3 placers yielded $2,014 in gold and 117 ounces of silver, and a small quantity of copper. The total output was valued at $2,089. Part of the ore produced was treated at the amalgamation mill on the Tilton property. A small test shipment was made from the Brooks claim.

Summit Valley or Butte district.[1]—At the end of 1912 the Butte-Central mill for the treatment of ores from the Ophir mine was nearly completed. It is expected to save 64 per cent of the gold and 40 per cent of the silver by concentration, making an added recovery of 35 per cent of the gold and 43 per cent of the silver by cyaniding the tailing. The Butte-Duluth Mining Co. is a new organization controlling the Montgomery and Macarona and portions of the Altoona, Amazon, and Colleen Bawn claims, lying east of the East Butte and adjoining the Bullwhacker properties. Large bodies of siliceous copper ores are reported to exist in these properties, and two experimental leaching plants have been erected. Interesting experimental work has been in progress at the Butte Reduction Works, where tests have been made upon the tailing dump, in which there are estimated to be 1,500,000 tons containing 1 per cent of copper. The "minerals separation process" and the McQuisten tubes are used to determine which will give the maximum saving at the minimum cost.

Sinking has been resumed in the Pittsmont mine and will be carried to a depth of 2,000 feet. Levels will be opened at every 200 feet. The 1,200-foot is now the deepest working level, although the continuity of the ore bodies has been proved to a depth of 1,500 feet by means of workings extended from winzes sunk in various portions of the mine. An electric pump, taking care of all the mine water, is in operation on the 1,200-foot level.

A new concentration mill was begun for the Elm Orlu zinc ores on the north side of Timber Butte. The mill is to have a capacity of 500 tons per day.

The Anaconda Copper Mining Co.[2] property was operated and developed through 22 shafts. The development work was—

in the form of drifts, crosscuts, upraises, winzes, and shafts, 34.1 miles in all, and a large tonnage was thus added to the ore reserves. The shafts of the different properties were sunk during the year to additional depths, aggregating 4,736 feet.

The Modoc, Anaconda, St. Lawrence, Steward, and Tramway shafts were sunk to a depth corresponding to the 2,800-foot level of the High Ore mine, at which depth the new drain tunnels connecting all mines with the High Ore shaft will be established.

The developments generally have been satisfactory, but especially so in the ground tributary to the Leonard, Tramway, Badger State, West Gray Rock, Original Steward,

[1] Weed, W. H., Geology and ore deposits of the Butte district, Montana: Prof. Paper U. S. Geol. Survey No. 74, 1912, 262 pp.

[2] Ann. Rept. for year ending Dec. 31, 1912.

and Gagnon shafts. On the bottom level of the last three mentioned shafts a continuous shoot of ore of good grade and width was developed for a length of over 2,800 feet.

The 2,000-foot level of the Leonard shaft was partially developed during the year, and the showing at the deepest point thus far reached in the property was most gratifying.

While the Tramway shaft has reached a depth of 2,400 feet, the lowest lateral development is on the 2,200-foot level, where a fine body of ore, in width greater than on the level above and of equal grade, was disclosed by the crosscut.

An auxiliary shaft to the Badger State mine, known as the Emily shaft, located on the Emily claim, which had originally been sunk to a depth of 400 feet, was sunk an additional depth of 517 feet during the year, and connection made with the 1,000-foot level of the Badger State mine. Development work has been done on the 1,100, 1,300, 1,400, 1,600, and 1,800 foot levels of the Badger State mine, with very gratifying results. The mine made an average daily output of 550 tons of ore throughout the year. Sinking in the main shaft below the 1,800-foot level was started on December 19.

The West Gray Rock shaft was sunk to the 1,600-foot level during the year, and while the veins encountered in this territory are smaller than in some of the other mines, the results of development at the greatest depth yet attained in this property were most satisfactory.

On December 10 a fire was discovered in the stopes above the 1,700-foot level of the Steward mine, but was extinguished with comparatively little loss. * * *

The reduction works treated for all companies during the year 3,880,203.37 dry tons of ore and other cupriferous material at Anaconda, and 1,189,039.10 dry tons of ore and other cupriferous material at Great Falls. Of this, 4,486,872.98 tons of ore from company mines, 581,031.97 tons of purchased ore, and 1,337.52 tons of precipitates and cleanings from the old works were treated, from which there was produced 222,763,670 pounds of fine copper; 9,702,604.52 ounces of silver, and 52,563.891 ounces of gold at Anaconda; and 71,710,491 pounds of fine copper; 1,312,132.45 ounces of silver, and 8,750.576 ounces of gold at Great Falls; or a total production of 294,474,161 pounds of fine copper, 11,014,736.97 ounces of silver, and 61,314.467 ounces of gold. * * *

The East Butte Copper Co.[1] operated the Pittsmont smelter and produced from its properties at Butte—

99,458 tons of ore averaging 5.78 per cent copper.

Of this amount 72,865 tons averaged 6.98 per cent, and 26,593 tons averaged 2.48 per cent. Or, in other words, 73 per cent of the total was first class ore and 27 per cent of the total was second-class ore. There was treated a total of 181,774 tons of ore, producing 14,709,460 pounds of copper; 370,675 ounces of silver; 16,920 ounces of gold, and yielding a gross revenue of $2,841,204.46. After adding revenue from other sources and subtracting operating expenses and interest, the net revenue amounts to $1,048,600.72, and, deducting from this additions to equipment amounting to $64,-899.83, leaves a net operating surplus of $983,700.89. The average price per pound received for copper sold was 16.692 cents. The average cost of production per pound of copper was 9.698 cents, leaving a profit per pound of 6.994 cents. * * *

Mine developments for the year consisted in driving a total of 7,130 feet of drifts and cross-cuts. Most of this work was done on the 1,000-foot level in order to open up on this level the veins known on the eighth and twelfth levels. The work has, therefore, been mainly that of developing known ore bodies rather than exploring for new ones. It has, nevertheless, resulted in opening up several hitherto unknown ore bodies. One of these near the western end of the property, on what is known as No. 16 vein, contains a considerable body of ore of good smelting grade, and shows good prospect of opening out into an important development. No. 42 vein which had been cut but not much developed on the 800-foot level has been developed on both the tenth and twelfth levels and shows up very strong at both points. * * *

The concentrator has in the past been operated by water pumped from the mine. This water has become gradually more and more acid until this condition has become a serious item in the maintenance of the mill. To overcome this a pipe line has been laid to the plant from the water lands owned by the company to Elk Park.

The Butte & Superior Copper Co., Ltd.[1]—

was organized in the year 1906 and began development operations in 1907. The basis of the organization was a group of claims embracing about 89 acres in the northerly portion of the Butte district, including the "Black Rock" and con-

[1] Ann. Rept. for year ending Dec. 31, 1912.

tiguous claims, from which considerable quantities of comparatively high grade silver ore lying near the surface had been mined in the early history of the district. It was supposed that these enrichments in the shallower portions of the veins indicated underlying copper deposits similar to others of this region. A comprehensive plan of development was laid out, including the sinking of the deep shaft which is now known as the "Black Rock" shaft. The early workings on the Black Rock vein had only extended to a few hundred feet below the surface. The main shaft was sunk to a depth of 800 feet before any substantial amount of lateral development was undertaken. It was then discovered that instead of the upper deposits of silver ore being underlaid by copper bearing ores as had been presumed, the principal value of the veins under development lay in the zinc contents. During the years 1910 and 1911 the Black Rock shaft was continued to a depth of 1,600 feet and the principal vein developed to a greater or less extent at 200-foot intervals from the 800 to the 1,600 foot level. No metallurgical investigations were undertaken until the year 1910, at which time a lease was acquired on a milling plant at Basin, Mont., about 25 miles distant from Butte. Thereafter until about the end of 1911 this mill was operated irregularly on ores taken largely from development, and partially from mining operations. The mill was ill adapted to the treatment of these ores but was modified from time to time to better meet the requirements, and through the operation of it some indications were obtained as to the design and methods of operation required for a permanent plant, which it was decided in the year 1911 to locate at the mine. * * *

The principal developments, including the deep shaft, are located on the Black Rock claim. The vein or veins developed by these workings are typical of the Butte district, the principal work being done on what is known as the "Black Rock" and "Jersey Blue" veins although in the immediate vicinity of the Black Rock shafts the ore deposits are influenced by an intersection or consolidation of other veins belonging to the well-known "Rain Bow" lode system. Little development work has been done on the Black Rock shaft above the 1,000-foot level. Stations have been established and a small amount of work done on the 800 and 900 foot levels. The 1,000, 1,200, 1,300, and 1,400 foot levels have been developed for practically the entire length of the Black Rock claim, disclosing an ore body substantially continuous and of very uniform grade for the full length of the claim and varying in width from a few feet to over 100 feet. No work has been done on the 1,500-foot level, and the 1,600-foot level has been opened up to an extent little more than sufficient to accomodate a pumping station and other necessary facilities at the bottom of the shaft. The total amount of ore blocked out and ready for mining is approximately 1,200,000 tons, averaging 21.7 per cent zinc and 7.9 ounces of silver. Practically all of this tonnage is developed from the 1,000-foot to the 1,400-foot level, the 800, 900, and 1,600 foot levels being credited with only such amounts as are actually disclosed by the limited developments at those places. * * *

The mill is designed in two sections, each being independently operated by electric power and having a maximum capacity each of about 600 tons per day, or a total capacity for the mill of about 1,200 tons per day. The rock breakers are located at the shaft, the ore being discharged automatically to them by the skips from the mine. A belt conveyor transports the coarsely crushed ore to a coarse crushing plant which reduces it to approximately ¾-inch size and from this department it is again conveyed to storage bins over the fine crushing department of the mill. The crushing and grinding machinery of the concentrator consist of rolls, tube mills, and pebble mills. The concentrating facilities for the recovery of the coarser minerals consist of concentrating tables, classifiers, and jigs and from these are produced from one-third to one-half of the total values recovered. The tailings resultant from the ordinary methods of wet concentration are reground and treated by so-called "flotation" methods. At the time of writing this report the flotation plant has not been completed to a capacity commensurate with that of the other portions of the mill, and it is accordingly impossible to economically handle all of the finer products. When operating at a capacity proportionate to the existing facilities, recoveries of above 80 per cent are made regularly, and under favorable conditions recoveries of 90 per cent of the zinc contents are readily obtained. Sufficiently comprehensive and continuous results have been obtained to warrant the assurance that when the remodeling of the mill is completed and its various departments balanced, the regular recoveries on a normal grade of ore and at full mill capacity will approximate 90 per cent with the probability that they may reach or even exceed that figure.

From the North Butte property[1] there—

were shipped 434,854 wet tons of ore and 78 wet tons of precipitates and there were treated at the smelter 425,248 dry tons of ore and 49 dry tons of precipitates, of which 45,346 dry tons, or 10.7 per cent, were first class, and 379,902 dry tons, or 89.3 per cent, were second class. This ore produced 26,480,123 pounds of fine copper, 1,377,468.44 ounces of silver, and 1,367.076 ounces of gold. * * *

The mine was in operation 342 days, the average number of men employed 902½, and the average number of tons hoisted per day was 1,269.56.

Our ore reserves have increased very largely during the year and now stand at a higher figure than at any previous time in the company's history. This ore in reserve will average 4.5 per cent copper and 4.5 ounces silver per ton, the further increase in silver values being due to the additional amount of ore developed during the year in the Snowball vein.

The principal feature of our development work, in addition to finding the eastern extension of the ore on the Snowball vein, was the discovery of a body of ore in the Edith May vein on the 2,400-foot level comparable with the ore disclosed in this vein on the upper levels, thus giving promise that this vein has again resumed its position as one of the principal ore-producing veins in our ground.

No development has been done on the Jessie vein on the lower levels, but from the showing of the vein in the crosscuts on the 2,600 and 2,800 foot levels there is a strong probability that we shall have parallel conditions in the Jessie vein also.

During 1912 the Tuolumne mine[2]—

produced 46,683 tons of ore, the same containing 4,716,047 pounds of copper, 131,867 ounces of silver, and 259 ounces of gold.

The average copper contents of the first-class ore mined during the year was 7.35 per cent. The average value of the silver was 3.38 ounces. The average value of the second-class ore was 4.05 per cent, and of the silver 2.58 ounces per ton. The gross value of these metals was $739,196.08. The net value after deducting smelter and freight charges was $415,528.55. * * *

The working shaft of the mine, composed of three compartments, has been sunk to a depth of 205 feet, the bottom of the shaft on December 31 being at a point 80 feet below the 2,000-foot station. * * *

No ore was taken from the 2,000-foot level, nor from the 800-foot level, all of the production being from the 1,200-foot, the 1,600-foot, and the 1,800-foot levels.

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[1] Ann. Rept. North Butte Mining Co. for the year ending Dec. 31, 1912.
[2] Ann. Rept. Tuolumne Copper Co. for the year ending Dec. 31, 1912.

NEVADA.

By V. C. Heikes.

PRODUCTION.

For the calendar year 1912 the production of gold, silver, copper, lead, and zinc, in bullion, ore of shipping grade, and concentrates from the combined mine output of 704 producers in Nevada had a total value of $38,358,732, as against an output valued at $33,952,529, made by 661 producers, in 1911. The difference of $4,406,203 in these totals was caused by an increase in value of the silver, copper, lead, and zinc yields, which was partly offset by the large decrease in gold production, amounting to $4,737,217.

White Pine County produced in 1912 the largest total value of metallic output, chiefly in copper, or $11,706,745, from 3,024,588 tons of ore. Nye County ranked next in value of output with $9,403,534, chiefly from silver, recovered from 575,742 tons of ore. Esmeralda County followed with a mine output, chiefly in gold, valued at $7,225,942, from 538,261 tons of ore. Lyon County mines produced 243,684 tons of ore, with the principal output in copper, valued at $2,881,609. Clark County produced 33,028 tons of ore, valued at $1,433,443, chiefly for lead and zinc. Storey County producers yielded 112,001 tons of ore, containing gold and silver only, valued at $1,352,089.

At gold and silver mills 1,309,339 tons of ore, or 27.49 per cent of the total ore mined, was treated by the amalgamation and cyanidation processes, by which were recovered $11,030,738 in gold, or 81.98 per cent of the State total, and 10,002,279 ounces of silver, or 69.61 per cent of the total. Smelters treated 376,800 tons of crude ore, from which were recovered 36,996.70 ounces of gold, 1,546,220 ounces of silver, 21,423,801 pounds of copper, 6,558,003 pounds of lead, and 4,669,816 pounds of zinc, with a combined value of $5,867,968. The smelters also treated 353,563 tons of concentrates, containing 63,344.08 ounces of gold, 2,301,694 ounces of silver, 64,979,228 pounds of copper, 5,913,188 pounds of lead, and 8,653,172 pounds of zinc, with a value of $14,309,715. Therefore, the smelters received ore and concentrates containing 15.41 per cent of the gold, 26.78 per cent of the silver, all of the copper, lead, and zinc, and 52.93 per cent of the total value of the deep-mine output.

Statistics of Nevada's ore output and its metallic content produced during the last nine years are as follows:

Ore sold or treated in Nevada in 1904–1912, number of producers, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	158	323,670	$5,060,494	4,268,123	29,317	4,229,727	.....	$7,658,216
1905	132	432,202	5,269,819	6,482,081	413,235	3,457,124	697,757	9,453,114
1906	154	496,307	10,470,704	6,770,611	1,625,985	3,823,617	2,886,328	15,714,841
1907	229	723,581	12,099,455	7,083,603	1,782,571	6,271,341	2,168,783	17,591,486
1908	421	1,425,532	11,362,941	9,508,464	15,598,788	7,245,619	1,115,851	18,818,228
1909	417	2,982,607	16,239,963	10,981,061	57,976,477	9,840,791	3,013,352	30,072,932
1910	608	3,655,775	18,878,864	12,479,871	64,359,398	4,871,136	2,707,071	34,152,148
1911	661	4,132,721	18,193,397	13,184,601	67,377,518	3,263,657	3,548,032	33,952,529
1912	704	4,763,965	13,456,180	14,369,063	86,477,494	19,500,100	13,322,988	38,358,732
Increase (+) or decrease (−) in 1912		+631,244	−4,737,217	+1,184,462	+19,099,976	+16,236,443	+9,774,956	+4,406,203

[a] Includes placer production.

ORE PRODUCTION IN 1912.

The quantity of ore mined in Nevada and sold or treated increased from 4,132,721 tons in 1911 to 4,763,965 tons in 1912. The total average value decreased from $8.16 to $8 per ton and the gold and silver value from $6.04 to $4.63. In 16 counties in Nevada mines were producing gold, silver, copper, lead, or zinc in 1912, and in all of these counties except 4 increased quantities of ore were produced. The increase in ore output was 631,244 tons, nearly all of which was credited to White Pine County, at Ely, and Lyon County, at Mason, where large quantities of low-grade copper ore were handled. There were increases made in output of dry or siliceous ores from 1,341,495 tons mined in 1911 to 1,400,728 tons mined in 1912; in copper ores, from 2,778,325 tons to 3,276,169 tons; in lead-bearing ores, from 5,018 to 59,452 tons; in zinc ores, from 3,013 tons to 7,394 tons; and in lead-zinc ores from 4,654 tons to 20,054 tons. Of the siliceous ores, 575,731 tons were produced in Nye County, and 538,025 tons in Esmeralda County, the former county yielding from the mines larger quantities in 1912 than in 1911, and the latter a lessened quantity. Storey County mines produce siliceous gold and silver ores entirely, and they ranked third in output in 1912, with a production of 112,001 tons, which was 16,107 tons greater than in 1911.

The output of milling ores aggregated 4,320,315 tons, which is over nine-tenths of the total ore mined, and most of the remainder, or 376,800 tons, was shipped directly to the smelters. Of the total milling ore, 1,309,339 tons were treated by amalgamation and cyanidation processes, and the remainder, 3,010,976 tons, by concentration alone. Of the total dry or siliceous ores mined, 1,400,728 tons, valued for the gold and silver content, were produced in 11 counties and averaged $8.97 in gold, 9.38 ounces of silver, 0.42 pound of copper, and 1.47 pounds of lead per ton. Practically none of these ores were sulphides. Silver ores, classified under the heading of dry

or siliceous ores, aggregated 476,725 tons, produced in 5 counties, and averaging $4.64 in gold and 21.37 ounces of silver per ton. Mines in Tonopah district, Nye County, yielded 475,926 tons of dry or siliceous silver ores, and in Pioche district, Lincoln County, 32,202 tons of oxidized iron-manganese ores.

Lead-ore production increased in quantity from 5,018 tons in 1911 to 59,452 tons in 1912. This increase was chiefly from the mines in the Yellow Pine district of Clark County and the output of ore and tailings in the Pioche district of Lincoln County. The table following gives the number of mines from which was produced each kind of ore, with metallic content, in Nevada in 1912:

Output of ore and production of metals in Nevada in 1912, by kinds of ore.

Source of production.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	63	.....	11,206.22	4,474	.....	.....	.....
Dry or siliceous ore	400	1,400,728	608,132.86	13,135,677	594,973	2,053,789	.....
Copper ore	130	3,276,169	23,511.60	173,545	85,579,530	31,180	.....
Lead ore	118	59,452	8,085.83	841,733	291,960	11,477,188	.....
Zinc ore	13	7,394	4.26	510	.....	.....	4,217,123
Copper-lead ore	5	168	1.94	4,327	11,031	56,924	.....
Lead-zinc ore	1	20,054	.....	208,797	.....	5,881,019	9,105,865
Total	.....	4,763,965	650,942.71	14,369,063	86,477,494	19,500,100	13,322,988

The classification of ore produced from the mines in 16 counties is given as follows:

Subdivision of tonnage of ore sold or treated in Nevada, in 1912, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	58,433	.....	1	.....	.....	.....	58,434
Clark	4,385	581	699	7,309	.....	20,054	33,028
Douglas	38	17	19	.....	.....	.....	74
Elko	13,217	227	171	.....	91	.....	13,706
Esmeralda	538,025	26	210	.....	.....	.....	538,261
Eureka	21,077	68	913	.....	.....	.....	22,058
Humboldt	13,826	203	474	.....	.....	.....	14,503
Lander	17,420	227	998	.....	8	.....	18,653
Lincoln	32,845	7,331	53,772	85	68	.....	94,101
Lyon	4,105	239,579	.....	.....	.....	.....	243,684
Mineral	6,243	4,261	1,080	.....	.....	.....	11,584
Nye	575,731	4	7	.....	.....	.....	575,742
Ormsby	856	2	1	.....	.....	.....	859
Storey	112,001	.....	.....	.....	.....	.....	112,001
Washoe	2,069	561	58	.....	1	.....	2,689
White Pine	457	3,023,082	1,049	.....	.....	.....	3,024,588
Total	[a] 1,400,728	3,276,169	59,452	7,394	168	20,054	4,763,965
Average value per ton in gold and silver	$14.74	$0.18	$11.52	$0.05	$16.08	$6.40	$4.63

[a] Includes 36,485 tons of gold ore, 887,518 tons of gold and silver ore, and 476,725 tons of silver ore.

GOLD.

The output of gold decreased from 880,105.58 ounces, valued at $18,193,397, in 1911, to 650,942.71 ounces, valued at $13,456,180, in 1912. The largest decrease, or $4,047,328, was made by the mines in the Goldfield district, whose yield in gold was $10,287,075 in 1911 and $6,239,747 in 1912. Added to this decrease was that of Humboldt County of $295,935 in gold due to the lessened output of the National mines. These decreases were but little affected by gains in several counties, Churchill County increasing its gold yield $234,164, and comparatively small increases being recorded from Lincoln, White Pine, Clark, Lander, and Eureka counties. Decreases were made in all the other counties. Placer and surface mines worked by hydraulic and sluicing methods and by drift mining produced $231,653 in gold, which was $21,192 greater than the corresponding output of 1911. Most of the placer gold in both years was produced at Manhattan and at Round Mountain, in Nye County. The largest single gold output in Nevada in 1912 was made from the Goldfield Consolidated mines; other important producers were the mines at Tonopah, in Nye County. The combined gold production of Esmeralda, Nye, and Humboldt counties amounted to $11,066,273, which is nearly nine-tenths of the gold yield of the State, but is $4,793,319 less than in 1911. In the three counties amalgamation and cyanidation processes produced 473,531.33 ounces, of which the amalgamation process yielded bullion containing 88,978.96 ounces of gold, and the cyanidation process 444,632.96 ounces. Concentrates produced at milling plants contained 63,344.08 ounces of gold, of which White Pine County was credited with the largest yield, or 22,324.69 ounces, followed by Storey with 15,486.02 ounces, and by Nye County with 13,985.46 ounces. The greater part of the gold was contained in concentrates of iron and rich silver sulphides containing a little copper. Altogether there were produced from dry or siliceous concentrates 41,054.43 ounces, and from copper concentrates 22,286.92 ounces. Lead concentrate yielded only 2.73 ounces of gold. Crude ore shipped directly to smelters contained 36,996.70 ounces of gold. The largest quantities were credited to Esmeralda County, with 16,460.38 ounces, and to Humboldt County, with 6,418.73 ounces. The siliceous ores of shipping grade were valued as converter lining or flux, and contained 33,085.42 ounces of gold; 290,082 tons of copper ores contained 1,224.69 ounces of gold; and 17,650 tons of lead ores contained 2,680.41 ounces. Smaller amounts of gold were contained in copper-lead and lead-zinc ores.

Source of gold production in Nevada in 1912, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	
Churchill		17,325.67		0.03			17,325.70
Clark	4.74	2,356.09	44.08	1.26			2,406.17
Douglas	26.03	44.51		.04			70.58
Elko	37.30	4,156.70	6.35	1.98		0.83	4,203.16
Esmeralda	4.50	339,233.15	8.19	83.45			339,329.29
Eureka	498.31	4,636.44	.24	1,066.20			6,201.19
Humboldt	134.81	44,573.46	46.00	127.04			44,881.31
Lander	513.02	3,270.07	274.26	354.69		.24	4,412.28
Lincoln		973.11	72.13	6,344.33	4.26	.87	7,394.70
Lyon	12.09	3,043.90	15.19				3,071.18
Mineral	81.90	3,042.08	49.40	52.56			3,225.94
Nye	9,883.59	141,236.08	.24	.44			151,120.35
Ormsby		418.98	.97	3.53			423.48
Storey		41,384.52					41,384.52
Washoe	6.19	2,049.65	43.72	3.83			2,103.39
White Pine	3.74	388.45	22,950.83	46.45			23,389.47
Total	11,206.22	[a]608,132.86	23,511.60	8,085.83	4.26	1.94	650,942.71

[a] Includes 13,267.16 ounces from gold ores, 487,942.67 ounces from gold and silver ores, and 106,923.03 ounces from silver ores.

SILVER.

Silver production increased from 13,184,601 ounces in 1911 to 14,369,063 ounces in 1912, and in value from $6,987,839 to $8,836,974. The greatest part of the silver output, or 10,210,296 ounces, was produced in Nye County, a decrease of 707,967 ounces in quantity, but an increase in value of $492,653 over the production of 1911. The yield increased in Churchill, Lincoln, Storey, Clark, and Mineral counties. The largest silver producer was the Belmont mine, at Tonopah, with the Tonopah Mining Co. a close second. Milling plants in Nevada using amalgamation and cyanide processes produced bullion containing 10,002,279 ounces of silver, of which 60,403 ounces were recovered by amalgamation and 9,941,876 ounces by cyanidation. The two counties having the largest yield of silver by amalgamation were Humboldt and Nye counties, and by cyanidation, Nye County, with 8,120,025 ounces, followed by Churchill County with 1,250,799 ounces. At concentration mills concentrates were produced containing 2,301,694 ounces of silver, the largest part of which, or 2,008,655 ounces, was contained in dry or siliceous concentrates. About nine-tenths of the silver in these concentrates was produced after the recovery of the gold and silver bullion and before cyanide treatment. There were 5,106 tons of dry or siliceous concentrates produced at gold and silver mills, averaging 386.86 ounces of silver per ton, and 500 tons from concentration mills, averaging 66.89 ounces of silver per ton. Mills in Nye County produced most of this class of concentrate. Copper concentrate produced in White Pine County, aggregating 329,585 tons, contained 75,469 ounces of silver. Lead concentrate, of which 173 tons were produced, contained 11,655 ounces; and 18,199 tons of lead-zinc concentrate contained 205,915 ounces. Silver was contained in largest quantities in dry or siliceous ores of smelting grade, which aggregated 60,830 tons, containing 1,091,451 ounces of silver, and averaging 17.94 ounces per ton. Nearly all of this ore was shipped from mines in Nye County. Lead ores carried the next largest total of 348,974 ounces from 17,650 tons of ore, an average of 19.77 ounces per ton. The smallest silver average, with the exception of that which was recovered from zinc resi-

dues, was from copper ores of smelting grade, which contained 0.34 ounce per ton; zinc ores averaged 0.07 ounce per ton; copper-lead ores, 25.75 ounces per ton; and lead-zinc ore, 4.26 ounces per ton.

Source of silver production in Nevada in 1912, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Churchill	.....	1,434,061	.....	7	.....	.....	.....	1,434,068
Clark	.....	12,204	2,412	13,052	.....	.....	208,797	236,465
Douglas	5	42	27	149	.....	.....	.....	223
Elko	29	40,720	1,977	8,258	.....	3,074	.....	54,058
Esmeralda	2	162,800	85	12,844	.....	.....	.....	175,731
Eureka	34	9,229	378	18,666	.....	.....	.....	28,307
Humboldt	17	127,086	755	6,335	.....	.....	.....	134,193
Lander	87	54,675	961	39,153	.....	173	.....	95,049
Lincoln	.....	86,914	73,148	597,723	510	1,076	.....	759,371
Lyon	6	5,781	10	.....	.....	.....	.....	5,797
Mineral	82	187,049	11,529	121,615	.....	.....	.....	320,275
Nye	4,207	10,205,020	581	488	.....	.....	.....	10,210,296
Ormsby	.....	2,147	12	124	.....	.....	.....	2,283
Storey	.....	806,853	.....	.....	.....	.....	.....	806,853
Washoe	3	927	3,650	4,382	.....	4	.....	8,966
White Pine	2	169	78,020	18,937	.....	.....	.....	97,128
Total	4,474	[a]13,135,677	173,545	841,733	510	4,327	208,797	14,369,063

[a] Includes 4,247 ounces from gold ores, 2,945,215 ounces from gold and silver ores, and 10,186,215 ounces from silver ores.

COPPER.

Copper was produced in 16 counties in Nevada and aggregated 86,477,494 pounds, valued at $14,268,787, in 1912, as against a yield of 67,377,518 pounds, valued at $8,422,190, in 1911. White Pine County mines, mainly those at Ely, yielded 67,380,536 pounds of copper in 1912, an increase of 345,145 pounds over the production of 1911. Lyon County was the next in production, with 17,057,921 pounds in 1912, as against 2,727 pounds in 1911. Concentrates produced at milling plants contained most of the copper, or 64,979,228 pounds, and averaged 9.19 per cent of copper. Dry or siliceous concentrate contained 44,713 pounds of copper, most of it from concentrate residues from the gold and silver mills.

Source of copper production in Nevada in 1912, by kinds of ore, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Churchill	6,172	.....	24	.....	6,196
Clark	172	168,515	5,200	.....	173,887
Douglas	305	3,969	119	.....	4,393
Elko	958	61,049	7,549	6,166	75,722
Esmeralda	578,815	13,012	1,937	.....	593,764
Eureka	1,431	17,455	975	.....	19,861
Humboldt	913	38,899	919	.....	40,731
Lander	311	43,207	8,576	1,247	53,341
Lincoln	160	229,395	259,037	3,506	492,098
Lyon	128	17,057,793	.....	.....	17,057,921
Mineral	4,251	488,930	538	.....	493,719
Nye	14	332	81	.....	427
Ormsby	.....	137	.....	.....	137
Storey	1,322	.....	.....	.....	1,322
Washoe	.....	83,327	.....	112	83,439
White Pine	21	67,373,510	7,005	.....	67,380,536
Total	[a]594,973	85,579,530	291,960	11,031	86,477,494

[a] Includes 593,883 pounds from gold and silver ores and 1,090 pounds from silver ores.

LEAD.

The lead production in 1912 aggregated 19,500,100 pounds, valued at $877,505. Compared with the output of 1911, this is an increase of 16,236,443 pounds in quantity and of $730,640 in value. Lincoln County mines made the largest output, or 10,759,685 pounds, followed by Clark County with 6,555,565 pounds, and by White Pine County with 1,015,990 pounds. Over one-fifth, or 22.42 per cent, of the lead yield, or 4,371,984 pounds, was contained in lead ores shipped directly to smelters, which averaged 12.39 per cent of lead. The next largest yield was from dry or siliceous ores, including old tailings, shipped directly to smelters, containing 2,021,993 pounds, or an average of 1.66 per cent. Copper-lead ores contained 56,924 pounds, or 16.94 per cent. Concentrates produced at mills in Clark County yielded 5,793,103 pounds of lead. There were 173 tons of lead concentrate produced, containing 76,295 pounds of lead, averaging 22.05 per cent. Lead-zinc concentrate, aggregating 18,199 tons, yielded 5,792,929 pounds of lead, or 15.91 per cent.

Source of lead production in Nevada in 1912, by kinds of ore, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	6,194	.....	344	.....	.....	6,538
Clark	616	4,859	669,071	.....	5,881,019	6,555,565
Douglas	.....	.....	11,805	.....	.....	11,805
Elko	930	.....	94,999	42,928	.....	138,857
Esmeralda	2,591	.....	116,017	.....	.....	118,608
Eureka	11,575	.....	219,135	.....	.....	230,710
Humboldt	8,325	.....	59,265	.....	.....	67,590
Lander	99	.....	237,295	1,950	.....	239,344
Lincoln	1,979,830	13,754	8,754,211	11,890	.....	10,759,685
Mineral	30,867	332	267,399	.....	.....	298,598
Nye	700	.....	3,652	.....	.....	4,352
Ormsby	.....	67	170	.....	.....	237
Storey	3,612	.....	.....	.....	.....	3,612
Washoe	8,166	.....	40,287	156	.....	48,609
White Pine	284	12,168	1,003,538	.....	.....	1,015,990
Total	[a] 2,053,789	31,180	11,477,188	56,924	5,881,019	19,500,100

[a] Includes 2,052,360 pounds from gold and silver ores and 1,429 pounds from silver ores.

ZINC.

The output of zinc, calculated as spelter, aggregated 13,322,988 pounds, valued at $919,286, in 1912, against a yield of 3,548,032 pounds, valued at $202,238, in 1911. Nearly all of the metal is the output of Clark County, from mines in the Yellow Pine district. Some sulphide zinc ore of shipping grade, estimated to produce an average of 801.52 pounds of spelter per ton, was produced from one property in Lincoln County. Lead-zinc concentrates aggregating 18,199 tons yielded spelter averaging 475.69 pounds per ton. The ore shipments direct to the smelters consisted of zinc carbonate and silicate and a mixed zinc-lead-silver ore.

Source of zinc production in Nevada in 1912, by kinds of ore, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Clark	4,148,995	9,105,865	13,254,860
Lincoln	68,128	.....	68,128
Total	4,217,123	9,105,865	13,322,988

MINING INDUSTRY IN NEVADA IN 1912.

The increased metal prices in 1912 and the starting of the new custom copper smelter at Thompson, in Lyon County, did much in stimulating mining in Nevada, especially in the western section, along the California border. A serious labor strike during the month of October materially curtailed the copper production in White Pine County at Ely, but despite these conditions the State output of copper showed a large increase at the end of the year. The gold production suffered largely from reduction in value of the Goldfield mines output, but the silver output from the Tonopah mines was greatly increased over the production of the year before. Mines in the Fairview and Wonder districts, in Churchill County, were working to full capacity. Resumption of mining at the Quartette mines and the large production of zinc and lead from the Yellow Pine district, in Clark County, increased the value of the metallic totals considerably. In Eureka County, the railroad between Palisade and Eureka was again in operation, and prospects of a larger ore production are bright. Litigation and fire were contended with at the National mines in Humboldt County in 1912, so that the gold production was less there than in 1911. The suit over apex rights was settled in favor of the National mines, but the former heavy gold production was not repeated. The metallic output of Lincoln County was of importance through large shipments from the Prince mine and the Day-Bristol property at Pioche. Much of the material shipped was old tailings, which contained a small percentage of lead and a little silver. Rochester district, in Humboldt County, was given a boom, and mine owners made a few test shipments of ore averaging well in silver.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver ocntained in bullion produced in Nevada in 1912, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Churchill	58,392	35.55	33	15,242.85	1,250,799	$1,085,095
Clark	2,496	2,127.07	1,144	161.66	514	48,333
Douglas	12	21.53	9	.....	.....	451
Elko	13,118	1,806.35	1,284	1,928.63	30,195	96,569
Esmeralda	518,706	21,004.49	5,486	301,413.79	60,727	6,705,698
Eureka	21,000	.....	.....	4,576.97	4,822	97,580
Humboldt	12,787	28,629.57	34,210	685.44	4,734	629,946
Lander	4,209	2,392.50	957	342.55	32,822	77,313
Lincoln	600	600.00	150	.....	.....	12,495
Lyon	3,986	2,072.58	1,324	796.86	532	60,457
Mineral	2,506	403.41	182	1,086.57	33,170	51,312
Nye	561,232	22,921.16	11,578	98,876.90	8,120,025	7,518,725
Ormsby	20	.....	.....	418.98	2,147	9,981
Storey	107,749	4,631.91	3,056	19,065.26	401,380	738,593
Washoe	2,069	2,018.65	857	.....	.....	42,256
White Pine	457	314.19	133	36.50	9	7,336
Total	1,309,339	88,978.96	60,403	444,632.96	9,941,876	17,182,140

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1912, by counties.

County.	Gold.				Silver.	
	Placers.		Deep mines.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Fine ounces.*	
Churchill			17,325.70	$358,154	1,434,068	$881,952
Clark	4.74	$98	2,401.43	49,642	236,465	145,426
Douglas	26.03	538	44.55	921	223	137
Elko	37.30	771	4,165.86	86,116	54,058	33,246
Esmeralda	4.50	93	339,324.79	7,014,466	175,731	108,075
Eureka	498.31	10,301	5,702.88	117,889	28,307	17,409
Humboldt	134.81	2,787	44,746.50	924,992	134,193	82,529
Lander	513.02	10,605	3,899.26	80,605	95,049	58,455
Lincoln			7,394.70	152,862	759,371	467,013
Lyon	12.09	250	3,059.09	63,237	5,797	3,565
Mineral	81.90	1,693	3,144.04	64,993	320,275	196,969
Nye	9,883.59	204,312	141,236.76	2,919,623	10,210,296	6,279,332
Ormsby			423.48	8,754	2,283	1,404
Storey			41,384.52	855,494	806,853	496,214
Washoe	6.19	128	2,097.20	43,353	8,966	5,514
White Pine	3.74	77	23,385.73	483,426	97,128	59,734
Total	11,206.22	231,653	639,736.49	13,224,527	14,369,063	8,836,974

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Churchill	6,196	$1,022	6,538	$294			$1,241,422
Clark	173,887	28,692	6,555,565	295,000	13,254,860	$914,585	1,433,443
Douglas	4,393	725	11,805	531			2,852
Elko	75,722	12,494	138,857	6,249			138,876
Esmeralda	593,764	97,971	118,608	5,337			7,225,942
Eureka	19,861	3,277	230,710	10,382			159,258
Humboldt	40,731	6,721	67,590	3,042			1,020,071
Lander	53,341	8,801	239,344	10,770			169,236
Lincoln	492,098	81,196	10,759,685	484,186	68,128	4,701	1,189,958
Lyon	17,057,921	2,814,557					2,881,609
Mineral	493,719	81,464	298,598	13,437			358,556
Nye	427	71	4,352	196			9,403,534
Ormsby	137	23	237	11			10,192
Storey	1,322	218	3,612	163			1,352,089
Washoe	83,439	13,767	48,609	2,187			64,949
White Pine	67,380,536	11,117,788	1,015,990	45,720			11,706,745
Total	86,477,494	14,268,787	19,500,100	877,505	13,322,988	919,286	38,358,732

Tonnage of ore sold or treated, number of deep mines producing, and average value per ton of ores in Nevada in 1911 and 1912, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1912	Increase (+) or decrease (−).	1911	1912	1911	1912	1911	1912
Churchill	58,434	+ 38,971	14	10	$18.79	$21.24	$18.79	$21.22
Clark	33,028	+ 21,893	35	42	31.76	43.40	4.93	5.91
Douglas	74	+ 36	3	7	21.74	31.23	15.34	14.25
Elko	13,706	− 13,240	27	45	4.22	10.07	3.99	8.71
Esmeralda	538,261	− 36,492	64	64	19.68	13.42	19.65	13.23
Eureka	22,058	+ 6,424	13	22	7.25	6.75	7.06	6.13
Humboldt	14,503	+ 4,838	95	68	140.55	70.14	140.06	69.47
Lander	18,653	+ 2,483	20	32	9.35	8.50	9.12	7.45
Lincoln	94,101	+ 68,458	14	19	4.79	12.64	3.91	6.59
Lyon	243,684	+226,939	51	45	6.71	11.82	6.69	.27
Mineral	11,584	+ 755	56	114	17.98	30.82	17.07	22.61
Nye	575,742	+ 50,253	99	75	17.55	15.97	17.55	15.97
Ormsby	859	− 868	5	5	13.08	11.86	12.97	11.82
Storey	112,001	+ 16,107	34	30	13.61	12.07	13.61	12.07
Washoe	2,689	− 1,294	34	43	18.59	24.10	18.12	18.17
White Pine	3,024,588	+245,981	25	20	3.21	3.87	.18	.18
Total	4,763,965	+631,244	589	641	8.16	8.00	6.04	4.63

[a] Value per ton, placer product excluded.

Number of mines producing, classified by chief products, in Nevada in 1912, by counties.

County.	Placer mines.		Deep mines.												Total mines producing.
	Hydraulic, dry, and sluicing.	Drift.	Gold.	Silver.	Copper.	Zinc.	Gold, silver.	Gold, silver, copper.	Gold, silver, copper, lead.	Gold, silver, copper, lead, zinc.	Gold, silver, lead.	Silver, copper.	Silver, lead.	Silver, lead, zinc.	
Churchill	....	....	....	....	....	....	8	1	1	....	....	....	....	....	10
Clark	1	....	....	....	2	5	9	7	6	[a] 4	1	[b] 3	1	[c] 4	43
Douglas	....	1	....	....	....	....	2	2	1	....	....	1	1	....	8
Elko	4	....	1	....	....	....	30	3	7	....	3	....	1	....	49
Esmeralda	1	....	4	1	1	....	32	3	3	....	13	[b] 4	3	....	65
Eureka	8	1	....	....	....	....	....	3	13	....	4	2	....	....	31
Humboldt	5	....	2	....	1	....	38	9	6	....	5	[b] 6	1	....	73
Lander	9	....	1	....	....	....	10	5	12	....	4	....	....	....	41
Lincoln	....	....	....	....	....	[d] 1	1	2	8	....	7	....	....	....	19
Lyon	2	....	2	....	23	....	16	[e] 3	....	....	....	1	....	....	47
Mineral	1	1	....	2	7	....	43	[e]21	7	....	5	[b]23	[f] 6	....	116
Nye	16	10	3	....	....	....	67	1	2	....	1	[b] 1	....	....	101
Ormsby	....	....	....	....	....	....	4	....	1	....	....	....	....	....	5
Storey	....	....	....	....	....	....	28	1	1	....	....	....	....	....	30
Washoe	2	....	2	....	2	....	24	3	....	....	7	[b] 4	1	....	45
White Pine	1	....	....	....	....	....	3	3	7	....	5	1	1	....	21
Total	50	13	15	3	36	6	315	67	75	4	55	46	15	4	704

[a] 3 contain no gold.
[b] 1 contains also lead.
[c] 1 contains also gold.
[d] 1 contains also gold and silver.
[e] 1 contains no silver.
[f] 1 contains also copper.

Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1912, by counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill	....	360	1,918.00	170,058	6,097	6,194	....	$145,520
Clark	19,378	18,204	25.59	206,079	15	5,793,103	8,653,172	985,029
Esmeralda	2,858	230	446.13	2,774	36,888	....	....	17,015
Eureka	....	25	3.11	3,155	323	10,832	....	2,544
Humboldt	408	609	9,012.76	41,149	769	26,179	....	212,922
Lander	207	69	2.73	4,963	1,352	38,844	....	5,079
Mineral	212	76	108.58	5,616	16	10,334	....	6,167
Nye	....	2,457	13,985.46	1,596,337	....	....	....	1,270,852
Storey	2,687	1,924	15,486.02	195,508	1,322	3,612	....	440,743
Washoe	9	21	31.01	559	....	11,638	....	1,508
White Pine	2,985,217	329,588	22,324.69	75,496	64,932,446	12,452	....	11,222,336
Total	3,010,976	353,563	63,344.08	2,301,694	64,979,228	5,913,188	8,653,172	14,309,715
Subdivision by kinds of concentrates:								
Dry or siliceous		5,606	41,054.43	2,008,655	44,713	31,796	....	2,092,802
Copper		329,585	22,286.92	75,469	64,932,425	12,168	....	11,221,522
Lead		173	2.73	11,655	2,090	76,295	....	11,002
Lead-zinc		18,199	....	205,915	....	5,792,929	8,653,172	984,389

Kinds of concentrates and average metallic content of each kind produced in Nevada in 1912.

Kind and source of concentrates.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
Dry or siliceous:							
Gold and silver mills—	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	25,970	$47.72	92.00	0.02	.....	.....	$96.54
1912	5,106	154.17	386.86	.06	0.28	.....	392.54
Concentration mills—							
1911	243	27.69	160.03	.07	.97	.....	113.55
1912	500	122.94	66.89	3.82	.36	.....	176.89
Copper:							
Concentration mills:							
1911	242,099	1.76	.40	13.48	.....	.....	35.67
1912	329,585	1.40	.23	9.85	.....	.....	34.05
Lead:							
Concentration mills—							
1911	895	1.17	56.13	.03	29.07	.....	57.15
1912	173	.32	67.37	.60	22.05	.....	63.60
Gold and silver mills—							
1911	26	84.81	85.31	.53	9.02	.....	139.46
Zinc:							
Concentration mills—							
1911	446	.....	6.47	.....	15.58	23.57	44.33
Copper-lead:							
Gold and silver mills—							
1911	30	26.03	18.40	6.10	37.96	.....	85.23
Lead-zinc:							
Concentration mills—							
1912	18,199	.....	11.31	.....	15.91	23.77	54.09

Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1912, by counties.

County.	Crude ore to smelters.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill	42	129.30	13,178	99	344	.....	$10,809
Clark	9,364	87.11	28,728	173,872	762,462	4,601,688	399,984
Douglas	62	23.02	209	4,393	11,805	.....	1,861
Elko	588	430.88	22,550	75,722	138,857	.....	41,518
Esmeralda	16,266	16,460.38	106,742	556,876	118,608	.....	503,134
Eureka	1,058	1,122.80	20,296	19,538	219,878	.....	48,812
Humboldt	1,308	6,418.73	54,083	39,962	41,411	.....	174,405
Lander	1,237	1,161.48	56,220	51,989	200,500	.....	76,186
Lincoln	52,427	1,391.99	278,117	484,518	3,730,776	68,128	452,348
Lyon	239,698	189.65	3,935	17,057,921	.....	.....	2,820,897
Mineral	7,858	1,545.48	281,225	426,818	288,264	.....	288,298
Nye	6,448	5,092.16	445,630	427	4,352	.....	379,593
Ormsby	3	4.50	136	137	237	.....	210
Storey	916	2,181.33	206,136	.....	.....	.....	171,866
Washoe	611	47.54	7,547	83,439	36,971	.....	21,055
White Pine	38,914	710.35	21,488	2,448,090	1,003,538	.....	476,992
Total	376,800	36,996.70	1,546,220	21,423,801	6,558,003	4,669,816	5,867,968
Subdivision by kinds of ore:							
Dry or siliceous	60,830	33,085.42	1,091,451	550,260	2,021,993	.....	1,536,462
Copper	290,082	1,224.69	98,076	20,580,220	19,012	.....	3,482,724
Lead	17,650	2,680.41	348,974	282,290	4,371,984	.....	513,344
Zinc	7,394	4.25	510	.....	.....	4,217,123	291,383
Copper-lead	168	1.93	4,327	11,031	56,924	.....	7,083
Lead-zinc	676	.....	2,882	.....	88,090	452,693	36,972

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Nevada and shipped to smelters in 1912.

Kind of ore.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	60,830	33,085.42	1,091,451	550,260	2,021,993	.....	$1,536,462
Copper:							
Oxidized	147,703	1,186.63	92,034	9,424,660	19,012	.....	1,637,554
Sulphide	142,379	38.06	6,042	11,155,560	.....	.....	1,845,170
Lead:							
Oxidized	14,111	1,575.79	166,699	263,655	2,418,812	.....	287,444
Sulphide	3,539	1,104.62	182,275	18,635	1,953,172	.....	225,900
Zinc:							
Oxidized	7,309	.....	.....	.....	.....	4,148,995	286,280
Sulphide	85	4.25	510	.....	.....	68,128	5,103
Copper-lead:							
Oxidized	91	.82	3,074	6,166	42,928	.....	4,856
Sulphide	77	1.11	1,253	4,865	13,996	.....	2,227
Lead-zinc:							
Oxidized	676	.....	2,882	.....	88,090	452,693	36,972
Total	376,800	36,996.70	1,546,220	21,423,801	6,558,003	4,669,816	5,867,968

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Nevada and shipped to smelters in 1912.

Kind of ore.	Quantity.	Average.					
		Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous	60,830	$11.24	17.94	0.45	1.66	.....	$25.26
Copper:							
Oxidized	147,703	.17	.62	3.19	.....	.....	11.09
Sulphide	142,379	.....	.04	3.92	.....	.....	12.96
Lead:							
Oxidized	14,111	2.31	11.81	.58	8.57	.....	20.37
Sulphide	3,539	6.45	51.51	.26	27.59	.....	63.83
Zinc:							
Oxidized	7,309	.....	.....	.....	.....	28.38	39.16
Sulphide	85	1.04	6.00	.....	.....	40.08	60.04
Copper-lead:							
Oxidized	91	.19	33.78	3.39	23.59	.....	53.36
Sulphide	77	.30	16.27	3.16	9.09	.....	28.92
Lead-zinc:							
Oxidized	676	.....	4.26	.....	6.51	33.48	54.69
Total	376,800	2.03	4.10	2.84	.87	.62	15.57

REVIEW BY COUNTIES.

CHURCHILL COUNTY.

There was produced from 10 deep mines 58,434 tons of ore, which is 38,971 tons more than was produced by 14 deep mines in 1911. Only 42 tons, containing high silver and gold values with a little copper and lead, were shipped directly to smelters, and the remainder of the ore mined in the district, or 58,392 tons, was treated at two gold and silver mills equipped with the cyanide process, by which was produced bullion containing $315,833 in gold and 1,250,832 ounces of silver, having a total value of $1,085,095. The total county output in 1912 averaged $21.24 per ton, against $18.79 in 1911. In 1911 the county output of ore aggregated 19,463 tons.

Fairview district.—Nearly all of the ore produced in the district came from the Nevada Hills mine. The total output reported by 7 producers aggregated 30,016 tons, containing $200,410 in gold, 959,391 ounces of silver, 6,196 pounds of copper, and 6,538 pounds of lead, valued in all at $791,752, or an average of $26.38 per ton. Nearly all of the ore, or 29,976 tons, was treated in gold and silver mills by the cyanide process, yielding bullion containing 7,719 ounces of gold and 777,841 ounces of silver. The remainder of the ore, aggregating 40 tons, contained a small quantity of copper and lead, and was shipped directly to the smelters.

The Nevada Hills mine [1] and mill were operated about eight months during 1912. The ore production aggregated 29,984 tons, from which gold and silver bullion valued at $720,116.78 net, or an average value per ton of $24.02, was recovered. This represented a recovery of 90.2 per cent of the metals contained in the ore. In addition there were shipped 8 tons of ore, valued at $6,547.74, or an average value of $818.47 per ton. The total mine costs, including development, were $3.95 per ton and of milling the ore $3.07 per ton.

Jessup district.—Only 42 tons of ore were credited to the district, mined by two operators in 1912. Part of the ore produced gold and silver bullion and a small tonnage was shipped directly to the smelters.

Wonder district.—The only producer was the Nevada-Wonder mine,[2] which yielded 25,186 tons of ore treated at its cyanide mill, the capacity of which was increased from 60 to 115 tons a day. Bullion was produced containing 6,650 ounces of gold and 427,747 ounces of silver, representing a recovery of 94.49 per cent of the gold and 94.74 per cent of the silver content. The average cost of mining and milling was $7.73.

CLARK COUNTY.[3]

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Clark County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1911	35	11,135	$25,414	55,643	185,915	1,629,571	3,548,032	$353,713
1912	43	33,028	49,740	236,465	173,887	6,555,565	13,254,860	1,433,443
Increase (+) or decrease (−) in 1912		+21,893	+24,326	+180,822	−12,028	+4,925,994	+9,706,828	+1,079,730

In 1912, 33,028 tons of ore were mined in this county from 42 deep mines. This is 21,893 tons more than was produced from 35 deep mines in 1911. The total average value per ton amounted to $43.40 in 1912, against $31.76 in 1911, and the gold and silver value in this ore increased from $4.93 to $5.91 per ton. The ore of shipping grade aggregated 9,364 tons, which contained $1,801 in gold, 28,728 ounces

[1] Ann. Rept. Nevada Hills Mining Co. for year ending Dec. 31, 1912.
[2] Ann. Rept. Nevada Wonder Mining Co. for year ending Sept. 30, 1912.
[3] Ball, S. H., Notes on the ore deposits of southwestern Nevada and eastern California: U. S. Geol. Survey Bull. No. 285, 1906, pp. 53-73; see also Bull. No. 308, 1907, 218 pp.

of silver, 173,872 pounds of copper, 762,462 pounds of lead, and 4,601,688 pounds of zinc, valued in all at $399,984, or an average value per ton of $42.72. At concentration plants 19,387 tons of ore were treated, producing a lead-zinc concentrate. At gold and silver mills 2,496 tons of ore were treated, containing $47,313 in gold and 1,658 ounces of silver.

Crescent district.—Two reports received from ore producers gave a production of 47 tons of ore, all of which, with the exception of 2 tons containing copper, was treated at a gold and silver mill with amalgamation and concentration equipment. The principal part of the production came from the Golden Calf mine, at which a 1-stamp Nissen mill with concentrator was in operation.

Eldorado Canyon district.—Five producers in 1912, against 6 in 1911, reported a production of 137 tons of ore, the larger part of which, or 94 tons, containing gold and silver and small quantities of copper and lead, was shipped directly to smelters. The remainder of the output was treated at a gold and silver mill. The total output was valued at $7,198.

Gold Butte district.—Oxidized copper ore was produced and shipped from the property of the Lincoln Copper Co.

Logan district.—Production of ore and placer bullion from this district amounted in value to $6,903, the larger part of which was for copper contained in 98 tons of ore shipped directly to smelters.

Searchlight district.—Ores aggregating 4,158 tons were produced from 9 properties in 1912, and yielded $46,244 in gold, 2,562 ounces of silver, 10,126 pounds of copper, and 10,032 pounds of lead, valued in all at $49,942, or an average value of $12.01 per ton. The bulk of the ore, or 2,238 tons, was treated at gold and silver mills by amalgamation. This output included bullion extracted from the treatment of old tailings from the Quartette mill by the cyanide process. The Quartette mine produced the larger part of the ore mined in the district, and important quantities were mined from the Chief of the Hills, and test runs were made on ores from the property of the Searchlight Mining & Milling Co.

Sunset district.—The Lucy Gray mine, the only producer of gold in the district, is situated 3 miles east of Lyons, a small station on the Salt Lake route in California. The property is developed by a shaft 300 feet deep. At a depth of 80 feet a body of milling ore averaging $5 in gold and silver per ton is reported to be 30 feet wide. The milling plant is equipped with one Lane slow-speed Chilean mill, and direct leaching of the ore in tanks by cyanide solution is practiced.

Yellow Pine district.[1]—From 22 deep mines 28,386 tons of ore were produced, containing $34 in gold, 223,013 ounces of silver, 103,398 pounds of copper, 6,544,917 pounds of lead, and 13,254,860 pounds of zinc, valued in all at $1,363,354, or an average value of $48.03 per ton. Of the ore produced, 9,008 tons were shipped without treatment and contained 1.63 ounces of gold, 17,098 ounces of silver, 103,398 pounds of copper, 751,988 pounds of lead, and 4,601,688 pounds of zinc (figured as spelter). There were 19,378 tons of ore milled, which ordinarily would have been of shipping grade, but was found capable of separation and produced a lead concentrate and a zinc concentrate, the total of which aggregated 18,199 tons. The

[1] Bain, H. F., A Nevada zinc deposit: Bull. U. S. Geol. Survey No. 285, 1906, pp. 166–169.

Yellow Pine mine was the largest producer, and other producers of mention were the Alice, Hoosier, Ingomar, Lucky Strike, Monte Cristo, New Year, Ninety Nine, Potosi, Prairie Flower, and Mountain Queen properties.

An account of the zinc-lead ore dressing at Goodsprings, prepared for this report by James M. Hill, of the United States Geological Survey, who visited the mines and mill, follows:

ZINC-LEAD ORE DRESSING AT GOODSPRINGS, NEV.

By James M. Hill.

The mill now used by the Yellow Pine Co. was originally built, according to the statement of an original member of the company, by the Mineral Union Co. (Ltd.) in 1900 for the leaching of copper ores. It did not prove successful and was allowed to remain idle for several years. In 1911 the Yellow Pine Co. began the alteration of this mill to treat by concentrating methods the mixed lead-zinc ores of the Bybee mine. The mill has now been running for a little over a year on ore carrying 11 to 11.7 ounces of silver per ton and from 16 to 17.5 per cent of lead and 27.8 to 29.8 per cent of zinc. The zinc is in the form of mixed smithsonite, calamine, and hydrozincite. The lead content is 75 per cent cerusite, the remainder being largely galena with some anglesite. The silver is almost entirely carried with the lead. From this class of ore Frederick A. Hale, superintendent of the mine and mill, estimates that 68.6 per cent of the lead, 92.2 per cent of the zinc, and 62.6 per cent of the silver are saved.

The mill can not be accurately described as a concentrating mill, for all of the products are marketed with the exception of a very small amount of waste rock taken from the picking belt. What are ordinarily called concentrates from the tables is the lead product, and is said to average 40 ounces of silver per ton and 57.5 per cent lead and 10 per cent zinc. The tailings that are waste in ordinary practice are in this mill the zinc product with a content of 4 to 6 ounces silver a ton and 33 to 35 per cent zinc and 6 to 8 per cent lead.

The method of separation is unique, and it was only after a number of failures with ordinary milling machinery that Mr. Kent and his associates hit upon this method, which the figures quoted show to be highly successful.

Much of the material here given is taken from the descriptive articles by Mr. Hale, which have appeared in various technical journals.

The ore when hoisted at the Bybee shaft is put over a 1-inch mesh shaking screen, through which about 50 per cent of the material passes. The two products, coarse and fine, are kept in separate lots from the mine to the two bins for crude ore at the mill. The coarse ore is dropped on an 18-inch picking belt about 30 feet long set at an inclination of 30°, which delivers the material to an 8 by 12 inch Blake crusher. Four ore sorters stationed along the belt pick out waste limestone from the coarse ore. The crusher reduces the ore to 1-inch size, which then drops into the fine ore bin together with the screened ore from the mine. The rough separation at the mine is done in order that the sorting and crushing may be accomplished during the day shift when there is good light. From the bin below the crusher the ore, now all 1-inch or less, is automatically fed into a 16 by 30 inch set of Gates rolls, which produces a ¼-inch pulp.

From the coarse rolls the pulp is elevated to a set of Colorado impact screens, 3 by 3 feet each. The coarsest screen has 4-millimeter openings and the finer is 20 mesh. The oversize from the coarse screen goes to a 2-compartment Hartz jig, though all material above half an inch in diameter goes back to the coarse rolls. From the hutch of the coarse jig a galena-cerusite concentrate is drawn and the tailings go immediately to the fine rolls. The oversize from the 20-mesh screen goes to a second Hartz jig, from which a hutch product is obtained that consists of about equal parts of cerusite and galena. The middlings from this jig go to the fine rolls, while the overflow is high enough in zinc to go direct to the dewatering bins. From the fine rolls crushing to 20-mesh, all the pulp returns through the above-described course.

The undersize from the 20-mesh screen is led into a specially built 6-compartment Overstrom hydraulic classifier, which is of the inverted type—that is, the slimes are taken out in the first compartment, which is said to be 90 per cent efficient. A constant hydraulic head is maintained by a separate tank equipped with a float valve. From the six boxes of the classifier the pulp is conducted to as many Overstrom "straight line" tables, each table being built for its previously determined pulp. The table for coarse pulp is 16 feet long by 4 feet 6 inches wide, and the slime table is 10 by 7 feet. The intermediate tables are of proportional length and breadth. All of

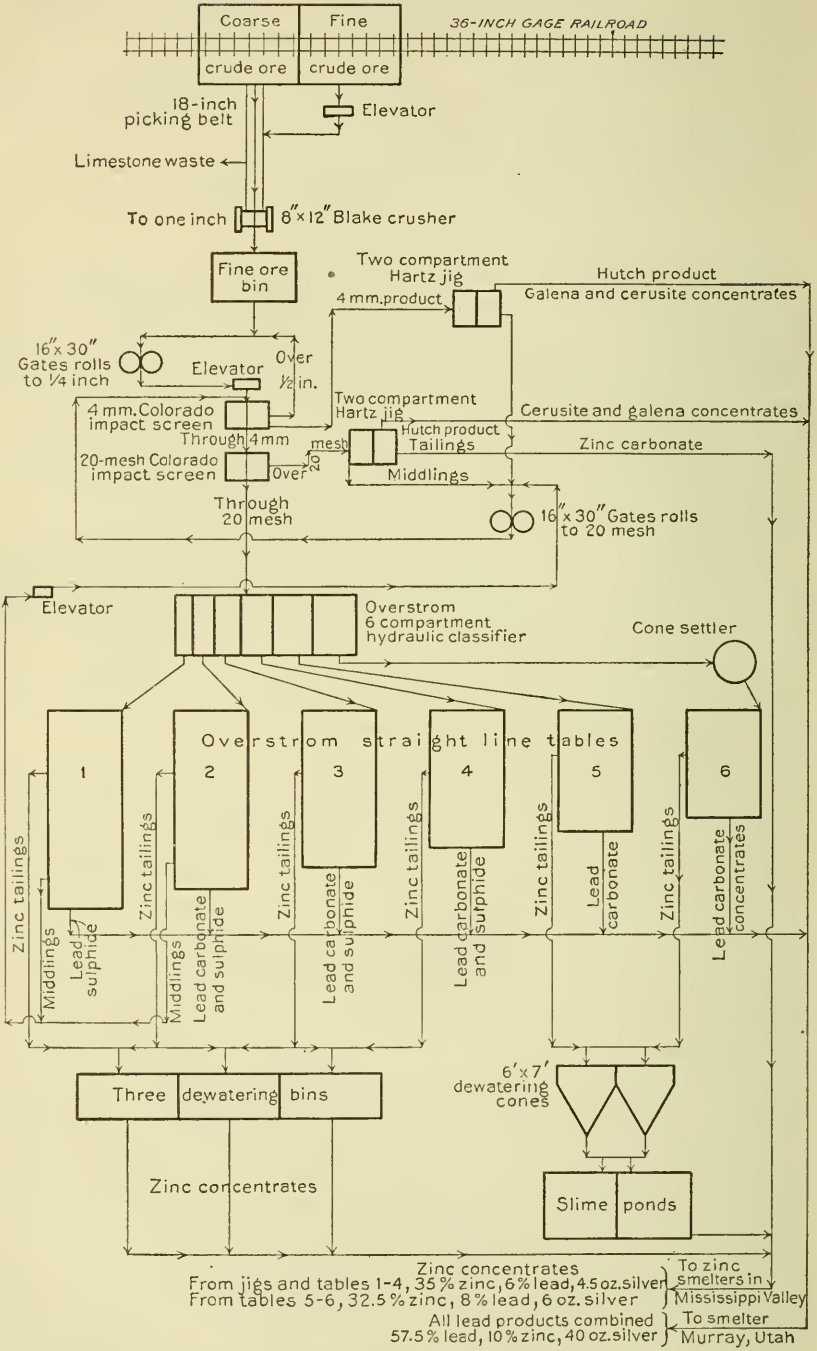

FIGURE 8.—Flow sheet of the Yellow Pine Mining Co.'s mill at Goodsprings, Nev.

the tables except the two treating the coarsest ore produce a lead concentrate and zinc tailings. The middlings from the two coarse tables are rich enough in both zinc and lead to be sent back to the fine rolls for re-treatment. The lead concentrate from the coarsest table is largely galena, from the second table is galena with considerable cerusite; from the tables taking the next two sizes it is about equal galena and cerusite, and from the two slimers, it is largely cerusite with little galena.

The lead concentrates from jigs and tables are all mixed together and carry, as before stated, 40 ounces silver per ton and 57.5 per cent lead and 10 per cent zinc.

The zinc tailings from the four coarse tables are led into three dewatering bins; while one is being filled, one is drying, and one is being emptied. From the slime tables the zinc pulp is dewatered in two 6 by 7 foot cones, and the thick red pulp runs into large ponds outside of the mill to dry. There are two of these ponds, one being filled and the other emptied. The zinc concentrates from the second jig and the four coarse tables carry 4.5 ounces of silver per ton, 35 per cent of zinc, and 6 per cent of lead. The slime zinc runs 32.5 per cent of zinc, 8 per cent of lead, and 6 ounces of silver.

The mill is rated at 80 tons per 24 hours, but in actual practice about 75 tons of crude ore are treated in the three 8-hour shifts.

The average output of the mill for the fall months of 1912 was said to be 1,500 tons of zinc concentrate and 300 tons of lead concentrate per month. Besides this, about 150 tons of crude ore are shipped during each month.

The concentrates are all allowed to dry partly in the open before shipment, as an excess of water adds to the freight charges. The zinc product is sent to either the Empire Zinc Co. or the United Zinc Co., whose smelters are in the gas belt of the Mississippi Valley. The lead is sold to the Murray plant of the American Smelting & Refining Co.

Water for the mill is supplied from several wells in Goodsprings. These are equipped with electric pumps and are not all used at the same time. The power is generated by a small dynamo, driven by the mill engine, which produces enough electricity to light the mill and a few of the houses in the village.

The water is not plentiful, so all the water from the dewatering bins and cones, together with a small quantity from the settling ponds, is pumped back to be fed with the ore into the coarse rolls. Fresh water is supplied to the separate tank that gives the head necessary for the classifier.

The Yellow Pine Mining Co. operates its own 36-inch gage road between the mine and the mill and from there to Jean. Two trips a day are made to the mine for ore and one trip a day is usually sufficient to transport the products to the San Pedro, Los Angeles & Salt Lake Railroad station at Jean. The Shay-geared locomotive used on the ore road pulls a train of seven 6-ton side-dump cars. The loading at both the mill and at Jean is done by hand, as it has been found that by this method the concentrates are given a better chance to dry.

Crude oil is used for fuel in the locomotive and for the boilers at the mill. This is obtained from the California fields and is laid down f. o. b. at Jean for $1.24 per gallon.

DOUGLAS COUNTY.

Seven deep mines produced 74 tons of ore in Douglas County in 1912, or 36 tons more than was produced by three deep mines in 1911. The total average value per ton increased from $21.74 in 1911 to $31.23 in 1912, but the gold and silver value in this ore decreased from $15.34 to $14.25 per ton. The bullion yield from placers amounted to $538 in gold and 5 ounces of silver.

Gardnerville district.—From 4 deep mines and 1 placer a production of ore and bullion was reported valued at $2,281. There were 46 tons of ore mined, 36 tons of which, containing copper and lead and a small quantity of silver, were shipped directly to the smelters. The remainder was treated by the amalgamation process at a mill near Silver City. The principal production came from the Monarch mine, in the Pine Nut region. Copper ore was shipped from the Ruby Hill mine.

Red Canyon district.—Two producers reported the production of gold and silver ore, shipped to the Mason Valley smelter. The San Pan and the Taylor properties were producers of gold and silver ore.

Silver Glance district.—The Yankee Girl and the Mule Shoe prospects, near Wellington, produced gold and silver ore containing a small quantity of copper.

ELKO COUNTY.[1]

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Elko County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	30	26,946	$92,617	30,417	16,369	94,276	$115,026
1912	49	13,706	86,887	54,058	75,722	138,857	138,876
Increase (+) or decrease (−) in 1912		−13,240	−5,730	+23,641	+59,353	+44,581	+23,850

[a] Includes placer production.

Ore was produced from 45 deep mines in Elko County in 1912, aggregating 13,706 tons, which is 13,240 tons less than was produced by 27 mines in 1911. The total average value of the ore increased from $4.22 in 1911 to $10.07 in 1912, and the gold and silver value in the ore from $3.99 to $8.71 per ton. At gold and silver mills using amalgamation and cyanidation processes, 13,118 tons of ore were treated, yielding $77,209 in gold, and 31,479 ounces of silver, having a total value of $96,569. Crude smelting ores shipped directly to smelters aggregated 588 tons, containing $8,907 in gold, 22,550 ounces of silver, 75,722 pounds of copper, and 138,857 pounds of lead, valued in all at $41,518, or an average value per ton of $70.61. Bullion recovered from placer operations amounted to $771 in gold and 29 ounces of silver.

Aura and Centennial districts.—From 7 producers small quantities of ore aggregating 594 tons were mined, containing $6,601 in gold, 6,252 ounces of silver, 958 pounds of copper, and 930 pounds of lead, valued in all at $10,646, or an average value of $17.92 per ton. Gold and silver bullion was recovered from 529 tons of the ore. There were only 65 tons, containing copper and lead, shipped to the smelters from the district.

Contact district.—The Delano property yielded one small lot of oxidized copper ore produced from the Copper King claim. This ore was shipped to a smelter from Rogerson, Idaho, a station on the Oregon Short Line Railroad.

Dolly Varden district.—Copper ore, containing silver and a small amount of gold, was shipped from the Kinsley mine.

Ferber district.—Shipments of lead ore, containing copper and silver, were produced from the Salt Lake group, and copper ore containing gold and an excess of iron was produced from the Regent mine.

Gold Circle district.—Fourteen deep mines yielded 3,137 tons of ore, which contained $37,053 in gold and 5,173 ounces of silver, valued in all at $40,235, or an average value per ton of $12.83. There

[1] Emmons, W. H., Reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nev.: Bull. U. S. Geol. Survey No. 408, 1910, pp. 126.
Schrader, F. C., A reconnaissance of the Jarbidge, Contact, and Elk Mountain mining districts, Elko, County, Nev.: Bull. U. S. Geol. Survey No. 497, 1912, pp. 162.

were 3,113 tons of ore treated at gold and silver mills, principally by the cyanidation process, producing gold and silver bullion, and 24 tons, containing gold and silver, were shipped directly to the smelter. The principal production of ore came from the Rex mine and was treated in its cyanide mill, and ore from miscellaneous producers, forming an important part of the total, was treated at a custom mill by amalgamation. The Esmeralda mine was taken over by a new company and its mill, after producing an important amount of bullion, was closed pending the development of the mine.

Jarbidge district.—Seven producers mined in the district 2,893 tons of ore in 1912. The larger part of this tonnage is estimated to apply to the bullion credited to the district, which aggregated $21,642 in gold and 887 ounces of silver, with a total value of $22,188, or an average value of $7.67 per ton. The Pavlak and North Star properties were the largest producers.

Merrimac district.—Two carloads of oxidized copper ore were shipped to the smelter from the Copper Queen group on Lone Mountain. This ore contained silver and a small quantity of gold.

Railroad or Bullion district.—Four producers reported the production of 179 tons of ore, containing copper, lead, and silver, and a small quantity of gold, aggregating $9,369 in total value, or an average value of $52.34 per ton. The Standing Elk and Bullion mines were the principal producers of ore of shipping grade.

Spruce Mountain district.—The Polar Star mine yielded lead oxidized ore of shipping grade which contained less than 1 ounce of silver per ton and no gold. The property is developed by a 150-foot shaft.

Tecoma district.—A small production of lead sulphide ore was reported by one operator in 1912. This ore carried a very small amount of silver and gold.

Tuscarora district.—Ore from 4 deep mines aggregated 6,619 tons, most of which was treated at gold and silver mills by the cyanidation process. There were also shipped directly to smelters 31 tons of lead ore, containing gold, silver, and a small quantity of copper. The largest producer was the Dexter mines, at which a 40-stamp mill and a new 100-ton cyanide plant were operated.

ESMERALDA COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Esmeralda County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	65	574,753	$11,198,602	184,953	80,477	83,418	$11,310,442
1912	65	538,261	7,014,559	175,731	593,764	118,608	7,225,942
Increase (+) or decrease (−) in 1912		−36,492	−4,184,043	−9,222	+513,287	+35,190	−4,084,500

[a] Includes placer production.

The yield of ore from 64 deep mines in Esmeralda County aggregated 538,261 tons, which is 36,492 tons less than was produced by 64 properties in 1911. The average value per ton decreased from

$19.68 to $13.42 in 1912, and the gold and silver value of this ore from $19.65 to $13.23 per ton. At milling plants using the cyanide process, 518,706 tons of ore were treated, yielding $6,664,977 in gold, and 66,213 ounces of silver, valued in all at $6,705,698, or an average value per ton of $12.93. The shipping ore aggregated 16,266 tons, containing $340,266 in gold, 106,742 ounces of silver, 556,876 pounds of copper, and 118,608 pounds of lead, valued in all at $503,134, or an average value per ton of $30.93. In 1911 only 2,822 tons of ore of shipping grade, containing the same metals, were produced, which had a total average value of $42.69 per ton. The quantity of concentrates shipped decreased from 21,396 tons in 1911 to 230 tons in 1912. This decrease in the shipments of concentrates was due to the treatment by the Goldfield Consolidated Co. in the Goldfield district of its own concentrates by the cyanide process and the reduction of the residues in furnaces built for the purpose. The placer production of the county consisted of $93 in gold and 2 ounces of silver.

Basalt, Buena Vista, or Oneota district.—Near Sunland, in this region, the Tip Top mine was operated, producing siliceous gold and silver ore, which was shipped to the smelter. The property is opened by 500 feet of drifts and is being developed to produce sufficient ore for a 100-ton cyanide plant, which was reported under construction in 1913.

Cuprite district.—Two producers reported the production of oxidized lead, and copper ore.

Dyer district.—Only one producer reported the production of lead-silver ore.

Gold Mountain district.—Eight producers reported the production of 1,439 tons of ore, yielding $24,346 in gold, 8,781 ounces of silver, 41 pounds of copper, and 10,253 pounds of lead, valued in all at $30,214, or an average value of $21 per ton. Most of the ore, or 1,147 tons, was of shipping grade and contained all of the copper and lead, and 292 tons were treated at a cyanide mill, yielding gold and silver bullion. The chief producer of ore was the Tonopah Gold Mountain Mining Co., and small productions were reported from the Nevada Crown and Hard Luck claims.

Goldfield district.[1]—The table following shows the production of metals and ores in the Goldfield district from 1904 to the end of 1912:

Ore sold or treated in Goldfield district, Esmeralda County, Nev., in 1904–1912, and total content of gold, silver, copper, and lead.

Year.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	8,000	$2,341,979	19,954	.....	.....	$2,353,353
1905	(a)	1,882,951	8,589	.....	.....	1,888,139
1906	59,628	7,026,154	15,648	.....	.....	7,036,638
1907	101,136	8,408,396	71,710	.....	.....	8,455,725
1908	88,152	4,880,251	30,823	1,606	.....	4,896,799
1909	297,199	9,383,261	33,164	52,015	.....	9,407,268
1910	339,219	11,137,150	117,598	107,282	.....	11,214,278
1911	390,431	10,287,075	126,406	72,998	.....	10,363,195
1912	362,777	6,239,747	125,736	579,539	3,581	6,412 859
Increase (+) or decrease (−) in 1912	−27,654	−4,047,328	−670	+506,541	+3,581	−3,950,336

a Tonnage not reported.

[1] Ransome, F. L., Geology and ore deposits of Goldfield, Nev.: Prof. Paper U. S. Geol. Survey No. 66, 1909, 258 pp.

Twenty-five producers in 1912 reported the output of 362,777 tons of ore, which contained $6,239,747 in gold, 125,736 ounces of silver, 579,539 pounds of copper, and 3,581 pounds of lead, valued in all at $6,412,859, or an average value of $17.68 per ton. Smelters received 13,993 tons of this output, which yielded 14,609.87 ounces of gold, 72,796 ounces of silver, 542,651 pounds of copper, and 3,581 pounds of lead. At gold and silver mills there were treated 345,926 tons of ore, which yielded 286,787.26 ounces of gold and 50,164 ounces of silver. There were also produced from the milling of 2,858 tons of ore, 230 tons of copper concentrates containing high values in gold and silver. The shipment of concentrates after treatment by the cyanide process has been entirely discontinued by the Goldfield Consolidated mine, the largest producer in the district, as it has been found profitable to re-treat the residues of the concentrates in furnaces erected for the purpose on the property. Production of ore was reported from the Quartzite and Black Butte, Florence, Goldfield-Belmont, Combination Fraction, Thanksgiving Gift, Mohawk-Jumbo, Nevada Eagle, Sandstorm-Kendall, and Goldfield Consolidated mines.

According to the annual printed statement of the Goldfield Consolidated Mines Co.:[1]

The property produced 415,786 tons of ore of an average value of $19.77, or $8,220,238.57. Deducting metallurgical losses of $564,218.25 and the cost of a small amount of ore purchased from a neighboring property, viz, $3,974.69, leaves the values realized from the production of the period $7,652,045.63, or $18.40 per ton. The gross expenses of the period, which include mining, milling, transportation, construction, taxation, and general expense, were $2,765,646.08, leaving net realizations from operation $4,886,399.55. * * *

Ore production, values, and average per ton of ore.

	Production (short tons).	Total value.	Average per ton.
Tons milled	403,360	$7,962,849.52	$19.74
Tons shipped	12,426	257,389.05	20.71
Total production	415,786	8,220,238.57	19.77
Loss in tailings	.....	564,218.25	1.36
Value recovered	.....	7,656,020.32	18.41
Cost of ore purchased	.....	3,974.69	.01
Value realized	.....	7,652,045.63	18.40

Production by shafts.

Shaft.	Milling ore.			Shipping ore.		
	Short tons.	Average.	Value.	Short tons.	Average.	Value.
Combination	70,578	$18.88	$1,332,525.15	.....	.....	.....
Mohawk	140,147	18.66	2,615,751.60	.....	.....	.....
Red Top	18,748	22.15	415,225.88	.....	.....	.....
Laguna	36,951	13.01	476,064.48	185	$16.74	$3,097.52
Jumbo (Clermont)	128,618	23.10	2,970,749.51	12,241	27.62	338,056.53
Jumbo No. 2	8,678	17.58	152,532.90	.....	.....	.....
Total	403,360	19.74	7,962,849.52	12,426	27.45	341,154.05

[1] Ann. Rept. for 14 months ending Dec. 31, 1912.

* * * The mining cost was $3.39 per ton, which includes, as well as all stoping costs, the amount expended in doing 48,146 feet of development work. The cost shows an increase of $0.04 per ton as compared with the previous year. The cost of mining and milling, including concentrate treatment, is $5.38 per ton or a decrease of $0.24 per ton as compared with the previous year. The total operating costs, including construction, are $6.72 per ton, a decrease of $1.36 per ton as compared with cost of $8.08 per ton for the previous year. * * * The construction of the plant for roasting and recyaniding the tailing from the raw concentrate treatment plant, which was undertaken in September of 1911, was completed in February of 1912, and the plant has been in continuous service since that date. Its operation has eliminated the marketing of concentrate. * * * Total earnings for the 14 months' period were $7,518,934.52. Total expenses were $2,632,534.97, leaving net realizations from the 14 months' operations of $4,886,399.55. During this period four regular dividends at 30 cents per share each and two extra dividends at 20 cents per share each were disbursed, aggregating $5,694,636.80. These dividends exceeded the earnings of the period by $808,237.25.

Dividends since October 25, 1907, to October 31, 1912, amount to $6.70 per share of stock issued, or a total amounting to $23,839,067.

Horn Silver district.[1]—All the ore produced by 5 operators aggregated 34 tons, containing gold and silver valued at $2,095, which was shipped directly to the smelters. The principal production came from the Great Western claims.

Lida district.—The greater part of the production reported by six producers was from the treatment of old tailings by the cyanide process from the dump of the Stewart mill. Copper and lead ore, containing gold and silver, aggregated 46 tons, and was shipped directly to the smelters from the Eagle Pass, Tip Top, and four other properties.

Lone Mountain district.—Eight producers reported the output of 126 tons of ore, containing $722 in gold, 10,467 ounces of silver, 1,735 pounds of copper, and 83,517 pounds of lead, valued in all at $11,203, or an average value of $88.91 per ton. The General Thomas, known formerly as the Tonopah Belcher property, was a producer of a small tonnage of lead sulphide ore. The Quincy was a producer of oxidized silver-lead ore.

Montezuma district.—This district, situated 7 miles west of Goldfield, yielded from the operations of 7 small producers 24 tons of shipping grade ore, containing lead, silver, and a small quantity of gold.

Silver Peak district.[2]—The Pittsburg-Silver Peak, Mohawk-Alpine, and Silver Peak Valcalda properties yielded milling ores, which were treated in a 120-stamp mill. The ore was stamped to 30 mesh, followed by amalgamation and the regrinding of coarse sand in tube mill and the separation into sand and slimes. The slimes received treatment in Merrill presses and the sands were leached by cyanide solutions, from which the gold was precipitated with zinc dust.

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[1] Ransome, F. L., The Horn Silver district, Nevada: Bull. U. S. Geol. Survey No. 380, 1909, pp. 41–43.
[2] Spurr, J. E., Ore deposits of the Silver Peak quadrangle, Nevada: Prof. Paper U. S. Geol. Survey No. 55, 1906, 174pp.

EUREKA COUNTY.[1]

Mine production of gold, silver, copper, and lead, and number of producers in Eureka County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1911	19	15,634	$111,434	15,273	2,617	61,136	$122,607
1912	31	22,058	128,190	28,307	19,861	230,710	159,258
Increase in 1912		6,424	16,756	13,034	17,244	169,574	36,651

[a] Includes placer production.

Twenty-two producers in 1912, against 13 in 1911, mined 22,058 tons of ore, which is 6,424 tons more than the output of 1911. The total average value per ton decreased from $7.25 in 1911 to $6.75 in 1912, and the gold and silver value in this ore from $7.06 to $6.13 per ton. The bulk of the ore, or 21,000 tons, was treated at gold and silver mills, principally by the cyanide process, and yielded $94,614 in gold and 4,822 ounces of silver. There were also produced at the gold and silver mills 25 tons of lead concentrates. Ore of shipping grade aggregated 1,058 tons, containing $23,211 in gold, 20,296 ounces of silver, 19,538 pounds of copper, and 219,878 pounds of lead, valued in all at $48,812, or an average value per ton of $46.14. The placer production of the county amounted to $10,301 in gold and 34 ounces of silver, against a production of $9,160 in gold and 30 ounces of silver in 1911.

Antelope district.—A small shipment of oxidized copper ore was produced from the Prince of Wales claim and shipped to the smelter. The property is opened by an incline shaft 500 feet deep and has 700 feet of drifts.

Eureka district.[2]—There were produced from 16 properties 20,810 tons of ore, containing $116,648 in gold, 18,546 ounces of silver, 2,394 pounds of copper, and 195,036 pounds of lead, valued in all at $137,226, or an average value of $6.59 per ton. The larger part of the output was in bullion, estimated to have been recovered from 20,000 tons of ore. The ore shipped directly to the smelter aggregated 810 tons. The Eureka Windfall property was operated for a short time during the year, but the operating company became bankrupt and the property was taken in charge by the county sheriff. Beside the gold and silver bullion shipped from this property, a small quantity of lead oxidized ore was produced. Crude lead ore was also shipped from the property of the Excelsior Mining Co. and from the Borlasca mine.

Lynn district.—Nine placer producers yielded $10,301 in gold and 34 ounces of silver, against the production in 1911 by 6 placer operators of $9,160 in gold and 30 ounces of silver. Prospecting the quartz veins in the district continues, but no milling of the ore has been reported.

[1] Emmons, W. H., Reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nevada. Bull. U. S. Geol. Survey No. 408, 1910, 126 pp.

[2] Curtis, J. S., Silver-lead deposits of Eureka, Nev.: Mon. U. S. Geol. Survey, vol. 7, 1884, 200 pp. Hague, Arnold, Geology of the Eureka district, Nevada: Mon. U. S. Geol. Survey, vol. 20, 1892, 419 pp. Hahn, O. H., The smelting of argentiferous lead ores in the Far West [Nev.]: Mineral Resources U. S. for 1882, U. S. Geol. Survey, 1883, pp. 324–345.

Mineral Hill district.—Regular shipments of concentrate and bullion were made from the 1900 and the Hecla mines, which are developed by tunnels 743 feet and 650 feet long, respectively. The concentration and cyanide mill is of 200 tons capacity. It was remodeled and operated the last four months of the year. About 40 per cent of the ores produced from this property are sulphides.

Palisade district.—No operations were carried on at the Zenoli property, but a small shipment of siliceous gold and silver ore, containing a small quantity of lead and copper, was reported by a lessee.

HUMBOLDT COUNTY.[1]

Mine production of gold, silver, copper, and lead, and number of producers in Humboldt County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	103	9,665	$1,223,714	255,367	11,979	71,850	$1,363,789
1912	73	14,503	927,779	134,193	40,731	67,590	1,020,071
Increase (+) or decrease (−) in 1912		+4,838	−295,935	−121,174	+28,752	−4,260	−343,718

[a] Includes placer production.

The ore output of the mines of Humboldt County aggregated 14,503 tons, produced by 68 deep mines, which is 4,838 tons more than was produced by 95 operators in 1911. The total average value per ton decreased from $140.55 in 1911 to $70.14 in 1912, and the gold and silver value in this ore from $140.06 to $69.47 per ton. The bulk of the ore, or 12,787 tons, was of milling grade, treated by the amalgamation and cyanide processes, and produced $605,995. in gold and 38,944 ounces of silver, with a total value of $629,946, or an average value per ton of $49.26. In addition to the gold and silver bullion produced at these mills, there were also some concentrates, which, with those produced at regular concentration plants, aggregated 609 tons, containing $186,310 in gold, 41,149 ounces of silver, 769 pounds of copper, and 26,179 pounds of lead, valued in all at $212,922, or an average value per ton of $349.62. The ore of shipping grade aggregated 1,308 tons and contained $132,687 in gold, 54,083 ounces of silver, 39,962 pounds of copper, and 41,411 pounds of lead, valued in all at $174,405, or an average value per ton of $133.33. Placers in the county produced $2,787 in gold and 17 ounces of silver, as against a production of $5,280 in gold and 134 ounces of silver, in 1911.

Adelaide district.—Oxidized copper-gold ores were produced from the Licking and Broyles-Spencer properties.

Antelope district.—The Last Chance, Nevada Superior, and Majuba Hills properties produced 351 tons of ore, containing $11 in gold, 2,228 ounces of silver, 7,010 pounds of copper, and 32,297 pounds of lead, valued in all at $3,991. Most of the ore was of concentrating grade and produced a small quantity of lead concentrates. The ore of shipping grade aggregated 51 tons, and contained silver, copper, and lead.

[1] Ransome, F. L., Some mining districts of Humboldt County, Nev.: Bull. U. S. Geol. Survey No. 414, 1909, 75 pp.

Awakening district.—Gold ore containing a little silver was produced and shipped to the smelter from the Slumbering Hill and Saut Extension claims.

Barrett Springs district.—Six producers of ore shipped 193 tons, containing $2,952 in gold, 3,538 ounces of silver, 3,099 pounds of copper, and 29,685 pounds of lead, valued in all at $6,570, or an average value of $34.04 per ton. Iron sulphide ore, containing gold and silver, was produced from the Romola claim, and some ore was produced from the Eclipse group. Similar shipments were made from other properties.

Dun Glen, Central, or Chafey district.—The production of 1,025 tons of ore by 6 producers yielded $16,886 in gold, 3,829 ounces of silver, 1,467 pounds of copper, and 5,502 pounds of lead, valued in all at $19,731. The Mayflower, or Chafey Sims, was the largest producer of gold-silver ore. This property was in the hands of lessees who operated the 3-stamp milling plant equipped for amalgamating.

Gold Run district.—The Golconda Gold Ledge and Black Diamond groups were operated and produced 2,461 tons of ore, the largest part of which was treated in a 30-ton Lane amalgamation mill, producing gold and silver bullion.

Imlay district.—The total production of the district aggregated 278 tons of ore, containing $3,362 in gold, 4,517 ounces of silver, 356 pounds of copper, and 4,025 pounds of lead, valued in all at $6,380. The Imlay mine was the largest producer, yielding milling and crude shipping ore.

Jackson Creek district.—This district, 35 miles north of Sulphur, a station on the Western Pacific Railroad, produced 2 tons of oxidized copper ore from a prospect.

Lovelocks district.—Ore reported by 6 producers aggregated 62 tons, containing copper, silver, and a small quantity of gold.

National district.—The National Mines Co. was the principal producer and yielded over half of the gold produced in the county. The gold was extracted from the ore in a 5-stamp amalgamation and concentration mill, which was operated five months of the year. The mine, which was in continuous operation throughout the entire year, is opened by a vertical shaft 700 feet deep and by 4 adits. Winchell[1] describes the ore deposits of the district as follows:

> The ore deposits of the National district are all in quartz veins largely confined to the older volcanic series. There are two types of ores present—one is characterized by copper, lead, and silver, and the other by gold (with silver).
>
> The veins containing the base ores were produced after the extrusion of the older rhyolite, and probably before any of the later rocks; they cut the rhyolite and are not known to extend into the later rocks. The veins formed at this time contain a considerable variety of minerals; the chief gangue mineral is quartz accompanied in places by subordinate quantities of calcite and a little sericite; the chief ores include chalcopyrite, arsenopyrite, pyrite, bornite, stibnite, galena. They often contain an important amount of silver as well as copper and lead. Under favorable conditions they would yield fair returns, but on account of the comparative isolation of the district the have not yet produced any considerable amount of shipping ore.
>
> Gold ore is the important resource of the district. The vein of the National mine contains phenomenally rich gold ore in quartz. It occupies a fissure which was produced later than the veins containing base ores, and later than the older andesite. Faulting along this fissure has lowered the andesite (which probably formerly overlay the older rhyolite) of the hanging wall to a position on a level with rhyolite in the footwall. The fissure was filled by quartz containing argentiferous gold or electrum with small

[1] Winchell, A. N., Geology of the National district: Min. and Sci. Press, Nov. 23, 1912, p. 658.

amounts of pyrite and stibnite, and very little stephanite, native arsenic, galena, sphalerite, and chalcopyrite. After the formation of the ore, faulting continued along the vein; consequently, the ore is much broken and granulated, and rolled fragments are often found in the fault gouge. This post-mineral faulting movement along the vein occurred after the extrusion of the auganite, since fragments of this rock are now in the fault gouge. The metallic part of the ore consists of gold and silver usually in the ratio of about 1 to 1, as in electrum. The latter is intimately intergrown with finely granular quartz and partly inclosed by elongated prisms of quartz rudely parallel or radial. Stibnite and native arsenic intergrown with the quartz give it in places a dark gray to black color. The sulphides in this vein are intergrown with the quartz, but (except stibnite in a few cases) are not so closely associated with the electrum. Even the pyrite is rarely if ever directly intergrown with the gold. In occasional samples the gold ore is broken and recemented by white quartz containing a little pyrite. There is little evidence of secondary enrichment, and no abundant formation of secondary minerals of any kind in the National vein, but small quantities of the following secondary minerals have been observed: Calcite, orpiment, realgar, sericite, limonite, and pyrargyrite. Marcasite, native gold, and polybasite are reported as secondary minerals, but I have not observed them.

The ore occurs in a shoot of rather indefinite boundaries which has been proved to extend on the dip for a distance of about 700 feet and on the strike for a distance of 400 feet. The shoot is not known to extend to the surface at any point, and for about 60 feet from the surface downward the vein contained some silver, but no high-grade ore. No placer mines have been discovered in this vicinity, although erosion has been at work cutting down the surface and the outcrop of this vein for some time. It seems probable that the bonanza ore shoot never reached the surface of the earth, and also that the upper portion of the vein which has been removed by erosion did not contain any similar lens of high-grade ore. Most of the ore from the mine is worth from $30 to $60 per pound, and the total production since the discovery of the lode in 1907 is reported to have been between $3,000,000 and $4,000,000.

Lindgren [1] also described the geology in 1911.

Paradise Valley district.—Four deep mines produced 53 tons of ore, which with the production of one placer, yielded $780 in gold, and 2,492 ounces of silver, valued in all at $2,313. Part of the district output was recovered from ores treated in the small roller mill on the Bodenia property.

Rochester district.—The output reported by 5 producers aggregated 144 tons of ore, containing $491 in gold and 6,850 ounces of silver, valued in all at $4,704, or an average value of $32.67 per ton. All of the ore was shipped directly to the smelters for the purpose of testing the values. This new district recently organized is described by Schrader: [2]

> The district is easy of access, being 10 miles east of Nixon, formerly Oreana, the nearest station and ore-shipping point on the main line of the Southern Pacific Railroad, and 25 miles northeast of Lovelocks. * * * Nenzel Hill, in which lie the ore bodies from which the present production is chiefly derived, is situated in the eastern portion of the district and forms a part of the crest of the range between the head of Rochester Canyon on the west and South American Canyon on the east. It is a north-northeastward-trending oval part of the ridge about 3,000 feet long by 2,000 feet wide and rises 7,300 feet in elevation, or about 500 feet above the adjoining portions of the divide. In Nenzel Hill the veins, ten or more in number, vary from 100 to 3,700 feet in length and some apparently have a vertical range of at least 400 feet. The west vein or lode, now being worked chiefly on the Codd lease and the Platt lease, is about 32 feet in width and contains two veins, 7 to 8 feet wide, of good ore composed chiefly of alternating layers of quartz and silicified rhyolite. The workings on these veins have been continuously in ore.
>
> Lincoln Hill, which also contains producing properties and received much attention last winter is a prominent landmark in the western part of the district 2½ miles distant from Nenzel Hill, on the north side of Rochester Canyon, above which it rises 1,200 feet, or to 6,600 feet above the sea. Packard Hill, the seat of the new "strike,"

[1] Lindgren, W., Rough field notes in National Miner, Aug. 18, 1911, and also delivered before the Geological Society of Washington: Min. and Eng. World, Dec. 9, 1911, p. 1175. Republished in Mineral Resources, U. S. for 1911, pt. 1, U. S. Geol. Survey, 1912, pp. 679–680.

[2] Schrader, F. C., Press Bull. U. S. Geol. Survey No. 118, June, 1913.

is in the southern part of the district, at an elevation of about 5,800 feet, in the lower part of a broad ridge, and on the trend of the Nenzel Hill zone of mineralization.

The ore deposits of the district are chiefly quartz replacement veins in fissures and shear zones in rhyolite and rhyolitic rocks which are of great thickness. The rocks vary from felsitic to coarsely porphyritic. They are more or less silicified, devitrified, and sericitized and were referred by the geologists of the Fortieth Parallel Survey to the Triassic period. The rocks dip about 35° E., but the veins dip 60° W., and are approximately conformable with the dominant sheeting and shear structure of the country rock.

Rosebud district.—From the reports received from five deep mine producers and one placer operator, the gold and silver output was valued at $12,977. Most of the ore produced in the district was shipped directly to smelters and contained $117 in gold and 17,203 ounces of silver. The placer yield amounted to $2,213 in gold and 12 ounces of silver. The principal production was made from the Grubstake and the Abe Lincoln properties.

Seven Troughs district.—Eight producers reported the output of 4,439 tons of ore, which contained $295,913 in gold, and 40,775 ounces of silver, valued in all at $320,990, or an average of $72.31 per ton. Nearly all of the ore was treated at gold and silver mills by the cyanidation process, yielding gold and silver bullion. Some concentrates were also produced and shipped from one of these mills which are equipped with concentrating tables. Only 3 tons of crude ore, containing gold and silver, were shipped directly to the smelters. The Seven Troughs Coalition Co., controlling the Kindergarten, Wihuja, and Therian properties, was the largest producer. The Mazuma Hills and Fairview properties were under lease to the Quintin Co., which operated the Darby mill, equipped for amalgamation, cyanidation, and concentration.

Unionville district.—The output was 624 tons of ore, half of which was shipped directly to the smelters, containing gold, silver, copper, and lead. The remainder produced the bulk of the gold and silver bullion by the amalgamation and concentration processes. The Arizona mine was an important producer of gold and silver ores, and some lead was contained in concentrates shipped from the property.

Winnemucca Mountain district.—Gold and silver ore was produced from five properties and aggregated 147 tons. The larger part of the ore, or 133 tons, was shipped directly to the smelters and 14 tons were treated in gold and silver mills, yielding bullion by amalgamation. The output of the district had a total value of $9,942. The Rexal property was the richest producer.

Willow Point district.—One property, the Little Humboldt, yielded oxidized copper ore containing silver.

LANDER COUNTY.[1]

In 1912 there were 18,653 tons of ore mined by 32 producers in Lander County. This is 2,483 tons more than were produced from 20 properties in 1911. The average value per ton of the ore decreased from $9.35 in 1911 to $8.50 in 1912, and the gold and silver values from $9.12 to $7.45 per ton. The larger part of the ore, or 4,209 tons, was of milling grade, producing $56,539 in gold and 33,779 ounces of silver, valued in all at $77,313, or an average value per ton

[1] Emmons, W. H., Reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nev.: Bull. U. S. Geol. Survey No. 408, 1910, 126 pp.

of $18.37. At concentration mills 207 tons of ore were treated, yielding 69 tons of concentrates containing principally lead and silver with a little copper and gold. Shipping ore aggregated 1,237 tons, containing $24,010 in gold, 56,220 ounces of silver, 51,989 pounds of copper, and 200,500 pounds of lead, valued in all at $76,186, or an average value per ton of $61.59. Placer production of the county amounted to $10,605 in gold and 87 ounces of silver, as against a production in 1911 of $7,092 in gold and 67 ounces of silver.

Battle Mountain district.—The production of ore and placer bullion by 5 deep mines and 9 placer operators was valued at $28,539. There were 201 tons of ore shipped directly to smelters, containing copper and lead, and 174 tons were concentrated, and the product was shipped to smelters. The placer yield amounted to $10,605 in gold and 87 ounces of silver, against a production in 1911 of $5,541 in gold and 47 ounces of silver. Most of the gold output is from dry placers.

Bullion district.—The Maysville mine was operated until October, producing a sulphide iron ore, which contained gold, silver, and a little copper. The property is opened by a tunnel 135 feet long.

Gold Basin district.—One property, the Gold Basin, at Carroll, was operated and developed by lessees, during which time some gold-silver ore, containing a trace of copper and lead, was produced and shipped.

Cortez district.—The Cortez Metal and the Garrison properties were the only producers in 1912. The former operated a 100-ton cyanide plant about six months of the year on old tailings. Lead ore containing gold and silver and a small quantity of copper was shipped from the Garrison property.

Galena district.—There were 4 producers reporting the production of 307 tons of ore, containing $2,745 in gold, 4,083 ounces of silver, 29 pounds of copper, and 57,427 pounds of lead. The total output was valued at $7,845, or at an average of $25.55 per ton. The Iron Canyon produces a siliceous ore and the Marion group and the White mine a lead ore, mostly oxidized.

Hilltop district.—Five deep mines yielded 4,083 tons of ore, all of which, with the exception of 83 tons, was treated in a 10-stamp amalgamation mill. The total output of the district was $52,994 in gold, 2,832 ounces of silver, 5,174 pounds of copper, and 2,046 pounds of lead, valued in all at $55,682. The most important tonnage was produced from the property of the Philadelphia Western Co. and treated in the mill of the Hilltop Milling and Reduction Co. This mill was equipped for treating the ore by amalgamation in 1912, but is being changed to use the cyanidation process.

Jackson district.—Lead ore and free gold ore were produced from the Highland Basin property, which is developed by an incline shaft 120 feet deep. It is also equipped with a 3-stamp amalgamation mill of 2½ tons capacity.

Lander district.—Four deep mines produced 168 tons of shipping grade ore, containing $808 in gold, 9,853 ounces of silver, 7,579 pounds of copper, and 85,041 pounds of lead, valued in all at $11,946.

Reese River district.—The operators of 8 properties produced 86 tons of ore, of which 67 tons were shipped directly to smelters, containing principally gold and silver with traces of copper and lead. The remainder of the ore, or 19 tons, produced gold and silver bullion.

Lessees operated the Jack Pot and Hardy properties, producing a siliceous pyritic gold and silver ore, which formed the principal part of the total ore yield, valued at $3,665.

LINCOLN COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Lincoln County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1911	14	25,643	$7,582	174,774	17,382	455,490	.....	$122,882
1912	19	94,101	152,862	759,371	492,098	10,759,685	68,128	1,189,958
Increase (+) in 1912		+68,458	+145,280	+584,597	+474,716	+10,304,195	+68,128	+1,067,076

Through the operations of 19 producers, 94,101 tons of ore, including old tailings, were produced and shipped. This tonnage of material shipped is 68,458 tons more than was shipped by 14 operators in 1911. The total average value per ton increased from $4.79 in 1911 to $12.64 in 1912, and the gold and silver value in this ore from $3.91 to $6.59 per ton. The largest part of the shipments consisted of iron manganese ore, aggregating 52,427 tons, containing $28,775 in gold, 278,117 ounces of silver, 484,518 pounds of copper, 3,730,776 pounds of lead, and 68,128 pounds of zinc, valued in all at $452,348 or an average per ton of $8.63. Old tailings, largely from the Bullionville dump, aggregating 41,074 tons, were shipped and contained the bulk of the lead produced in the county. Gold and silver bullion was produced at milling plants, which was estimated to have come from 600 tons ore and aggregated $12,403 in gold and 150 ounces of silver. There was no placer production reported.

Bristol district.—Some dump ore and crude copper ore from the Home Run mine was shipped from the district in 1912, aggregating 317 tons.

Caliente district.—One producer reported the production of oxidized copper ore containing gold and silver from the Cherokee Nevada property.

Ferguson district.—A clean-up of the old Delamar mill by lessees was continued during the year, and a small quantity of material containing gold and silver was shipped.

Pioche district.—There were shipped by 13 operators 93,135 tons of crude ore and old tailings, containing $137,251 in gold, 750,229 ounces of silver, 457,083 pounds of copper, 10,741,499 pounds of lead, and 68,128 pounds of zinc, valued in all at $1,162,130, or an average of $12.48 per ton. Oxidized and iron manganese ores containing lead, silver, and gold form the largest part of the ore mined in the district. There was also a very large tonnage of old tailings shipped from the Bullionville dumps, owned by the Prince Consolidated Mining Co. Ore was shipped from the Day Bristol, Highland Mary, Hyman, and Mendha properties.

LYON COUNTY.

Operators of 45 deep mines reported the mining of 243,684 tons of ore, which is 226,939 tons more than was produced from 51 deep mines in 1911. The total average value per ton increased from $6.71 in 1911 to $11.82 in 1912, and the gold and silver value in this ore decreased from $6.69 to 27 cents per ton. The larger part of the output was shipped to smelters, aggregating 239,698 tons, which contained $3,920 in gold, 3,935 ounces of silver, and 17,057,921 pounds of copper, valued in all at $2,820,897, or an average value per ton of $11.77. Gold and silver mills, at which the amalgamation process was generally in use, treated 3,986 tons, yielding $59,316 in gold and 1,856 ounces of silver. The placer yield amounted to $250 in gold and 6 ounces of silver, as against a production in 1911 of $509 in gold and 13 ounces of silver.

East Walker district.—A small amount of gold ore was shipped from the Copper Queen claim, situated on Bald Mountain.

Silver City district.—Fourteen deep mine producers and 2 placer producers reported the production of 4,063 tons of ore, which, with the slight placer production, gave a total value of $65,302. The bullion recovered from the ore by amalgamation and cyanide processes contained 2,864.26 ounces of gold and 1,854 ounces of silver. There were also shipped directly to smelters 84 tons of ore containing 113.95 ounces of gold, 3,775 ounces of silver, and 128 pounds of copper. The placer yield amounted to $250 in gold and 6 ounces of silver. The ore milled was for the greater part treated at the McTigue mill, at which the amalgamation process was used. Most of the ore treated at this mill was mined from two or three properties in the district.

Yerington district.[1]—Numerous small operators of prospects in the district were encouraged to mine and ship ore to the Mason Valley smelter. Including the large producers, there were 28 mine operators reporting a total production of 239,606 tons of ore, containing $1,035 in gold, 34 ounces of silver, and 17,057,793 pounds of copper, valued in all at $2,815,592, and averaging $11.75 per ton. Some of the smaller shipments came from the Burlington Nevada copper claims, and the Copper Stone, Empire Nevada, Keynote, Mohawk, Snowstorm, New Yerington Copper group, Malachite, and Washington properties.

According to the statement of the Mason Valley Mines Co.:[2]

> The tonnage smelted during the year has been, 98,912 tons Mason Valley ore, 142,910 tons custom ore, 15,768 tons limestone. From the above there has been produced, 19,849 tons copper matte containing 16,058,493 pounds copper, 916.59 ounces gold, and 49,318.18 ounces silver. * * * Ore shipments were started from the Mason Valley mine on January 5, 1912. Previous to this date the property had been well developed and equipped to produce the tonnage which might be required to supplement the tonnage of custom ores. The tonnage shipped has come principally from the three stopes which were started above No. 3 tunnel level during the previous year. A number of irregular bunches of lime have penetrated the ore in places, lowering the grade of shipments but supplying a portion of the lime required to make a proper slag. In stoping these ore bodies by the shrinkage system, it has been found

[1] Ransome, F. L., The Yerington copper district, Nevada: Bull. U. S. Geol. Survey No. 380, 1909, pp. 99–119.

[2] Ann. Rept. for the year ending Dec. 31, 1912.

that in place of three separate ore shoots, there is one continuous ore body from 800 to 900 feet in length, the greater portion of which will be smelted at a profit. * * * The lime carbonate ore has been quarried from the surface. * * * This tonnage has been of value in making a suitable blast-furnace charge. Development work indicates the existence of a large tonnage of this material. The mining operations have been governed largely by the requirements of the smelter, shipments having been varied to make proper smelting mixtures with the custom ores received. The Mason Valley mine has supplied all fluxing material required in the smelting operations. Good limestone is being quarried from above No. 1 level. * * * The smelter was was blown in January 6, 1912, and one furnace has been in continuous operation since that time. The plant consists of two blast furnaces, which it was estimated would treat a minimum of 400 tons each of ore per day. These furnaces have exceeded this estimated capacity by approximately 100 per cent, and with the completion of enlargements now in progress, the plant will have a capacity of 1,800 tons of ore per day. * * * The product of the smelter is a copper matte containing approximately 40 per cent copper. * * * The custom-ore receipts at the smelter have been an important factor in the operations. During the year there has been received 146,530 tons of custom ore. These shipments have been made by more than 130 different shippers, and from 30 different mining districts located in Nevada and California. The present activity in the mining camps tributary to the smelter assures an even greater tonnage and the probable development of very important mines during the coming year.

The Nevada Douglas mines [1] yielded during its fiscal year—

120,908 wet tons, an average of 331.3 tons per day. In dry weight there were 106,483 tons, which produced 9,020,640 pounds of copper, or an average of 84.71 pounds of copper per dry ton of ore. During this same period leasers shipped 551 wet tons. * * * The tonnage shipped during the past year has been produced from all sections of the Ludwig and Douglas Hill mines. In the Ludwig our system of mining has been principally square-setting, as under existing conditions the ore could not be broken indiscriminately. In almost every level large blocks of ore averaging from 1 per cent to 3 per cent have been left, but particular care was given to their economical extraction in the future. Most of the stopes have been filled with this low-grade ore which we have been forced to move in connection with our development work. This mining of only better-grade ores has added largely to the cost per pound of copper, but lower costs will be attained when the lower-grade ores can be profitably mined along with the high grade. Douglas Hill is largely mined by the open-stope method, and no timbering is necessary aside from chutes and stulls.

MINERAL COUNTY.

In 1912 in Mineral County 114 producers reported the production of 11,584 tons of ore, which is 755 tons more than was produced by 56 operators in 1911. The starting of the Mason Valley smelter, situated at Thompson, Lyon County, caused a large number of mine owners to ship test lots of ore. This accounts for the unusual increase in the number of producers. The larger part of the output, or 7,858 tons, was shipped directly to the smelters, and contained $31,948 in gold, 281,225 ounces of silver, 426,819 pounds of copper, and 288,264 pounds of lead, valued in all at $288,298, or an average per ton of $36.69. At gold and silver mills 2,506 tons of ore were treated, yielding bullion containing $30,801 in gold and 33,352 ounces of silver, valued in all at $51,312, or an average value of $20.48 per ton. The placer yield amounted to $1,693 in gold and 82 ounces of silver, against a production of $6,699 in gold and 271 ounces of silver in 1911.

Aurora district.—Prospects are good for a large production from the Aurora mines after the completion of the large mill, which will be erected in 1913, for the reduction of the ores from this property by the cyanide process. The output in 1912, reported by 3 producers,

[1] Ann. Rept. Nevada Douglas Copper Co. for year ending May 5, 1913.

aggregated 138 tons and contained $1,275 in gold and 513 ounces of silver.

Columbus district.—Seven producers reported the production of 903 tons of ore, which was shipped directly to the smelters, containing $2,155 in gold, 26,959 ounces of silver, 1,166 pounds of copper, and 1,630 pounds of lead, valued in all at $19,001. The Bi-Metallic property, which was formerly the Swastika, shipped the largest quantity of gold-silver ore.

Gold Range district.—The Alice group produced a small test lot of oxidized copper ore, which was shipped to the Mason Valley smelter.

Hawthorne district.—Fifteen producers reported the production of 1,358 tons of ore, containing $3,677 in gold, 120,854 ounces of silver, 52,317 pounds of copper, and 185,284 pounds of lead, valued in all at $94,972, or an average value of $69.94 per ton. The largest part of the ore was shipped directly to smelters and aggregated 1,082 tons. The remainder was treated in a concentration mill, producing lead concentrates, and 64 tons were milled, producing gold and silver bullion. The principal production was from the Mountain King and Lucky Boy properties.

Klondyke district.—Ore was produced and reported by 10 operators, aggregating 1,800 tons, the larger part of which, or 1,750 tons, was shipped directly to smelters and contained 117.66 ounces of gold, 98,669 ounces of silver, 587 pounds of copper, and 53,881 pounds of lead. Gold and silver bullion was also reported as produced from the treatment of ore shipped to a local mill. The original Klondyke property was reported as a producer of gold and silver ore and crude ore shipped to the smelter, containing lead and a small quantity of copper.

Pine Grove district.—Two producers reported the production of bullion and crude ore shipped to smelters, valued in all at $8,911. The larger part of the ore production was treated at gold and silver mills, producing gold and silver bullion and concentrates. The Wheeler mine and mill were operated part of the year.

Rawhide district.—There were 19 deep-mine operators reporting the production of 1,579 tons of ore, the larger part of which was treated at gold and silver mills, producing gold and silver bullion recovered by the cyanide process. There were 285 tons shipped directly to the smelters containing 516.39 ounces of gold, 14,173 ounces of silver, 16,663 pounds of copper, and 418 pounds of lead. The Nevada New mines reported the largest production. This company is the successor to the Rawhide Coalition Mines Co.

Santa Fe district.—The larger part of 3,080 tons of ore mined in the district in 1912 by 34 producers was shipped directly to the smelter, and contained 338 ounces of gold, 17,053 ounces of silver, 311,543 pounds of copper, and 12,191 pounds of lead. There was also treated at a gold and silver mill a number of tons of ore yielding gold and silver bullion and some concentrate. The total value of the ore output amounted to $70,015. The Guardian Group, Luning Gold, New York, Vacation, High Ore, Shipper, and Independent were the principal ore producers.

Silver Star district.—Seventeen producers reported the shipment of 1,505 tons of ore and old copper slag. The crude ore shipped aggregated 635 tons and contained 344.19 ounces of gold, 7,663 ounces of silver, 33,359 pounds of copper, and 30,478 pounds of lead. The

total district output amounted to $29,739. The principal ore producers were the Sunshine, the Black Cat, and the Bird Song.

NYE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Nye County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	129	525,489	$3,617,276	10,918,263	2,264	2,808	$9,404,365
1912	101	575,742	3,123,935	10,210,296	427	4,352	9,403,534
Increase (+) or decrease (−) in 1912.		+50,253	−493,341	−707,967	−1,837	+1,544	−831

[a] Includes placer production.

Reports were received from 75 deep-mine producers in 1912 showing an output aggregating 575,742 tons of ore, which is 50,253 tons more than was produced by 99 deep mines in 1911. The average value per ton of the ore decreased from $17.55 in 1911 to $15.97 in 1912. This value in both years was entirely for the gold and silver content. The bulk of the output, or 561,232 tons, was treated at gold and silver mills, yielding $2,517,789 in gold and 8,131,603 ounces of silver, having a total value of $7,518,725, or an average value of $13.40 per ton. Concentrates produced from ore treated at gold and silver mills aggregated 2,457 tons, containing $289,105 in gold and 1,596,337 ounces of silver, valued in all at $1,270,852, or an average value per ton of $517.23. It has been found more profitable to treat the ores directly by the cyanide process than to separate the concentrates before cyanidation. Several mills have discontinued the practice of concentration, and it is presumed others will follow. Smelting ores shipped aggregated 6,448 tons, which contained $105,264 in gold, 445,630 ounces of silver, 427 pounds of copper, and 4,352 pounds of lead, valued in all at $379,593, or an average value of $58.87 per ton. The placer production amounted to $204,312 in gold and 4,207 ounces of silver, as against a production in 1911 of $178,430 in gold and 3,843 ounces of silver.

Antelope district.—Three mine producers shipped 161 tons of ore, yielding $1,810 in gold, 32,058 ounces of silver, valued in all at $21,526, or an average value of $133.70 per ton. The largest part of the production came from the property of the Antelope Mines Co.

Bellehellen district.—A small production of gold and silver was shipped from the Clifford mines.

Bruner section.—The Phonolite-Paymaster mine produced gold and silver ore of shipping grade.

Bullfrog district.[1]—The deep-mine production reported by 8 operators aggregated 2,683 tons. Most of this ore, or 2,574 tons, was of milling grade producing gold and silver bullion, and the remainder, 109 tons, was shipped directly to the smelter and contained copper and lead in addition to the precious metals. The largest part of the production came from the Tramps Consolidated and

[1] Ransome, F. L., Emmons, W. H., and Garrey, G. H., Geology and ore deposits of the Bullfrog district, Nevada: Bull. U. S. Geol. Survey No. 407, 1910, p. 128.

the Mayflower Bullfrog properties, both of which have milling plants in which the ore is treated by cyanidation.

Johnnie district.—The Johnnie mine was the principal producer and yielded gold and silver ore, which was treated in the amalgamation mill on the property.

Manhattan district.—All of the ore produced by 20 deep mines, or 21,064 tons, was treated at gold and silver mills and yielded 15,602.87 ounces of gold and 6,978 ounces of silver, valued in all at $326,831, or an average value of $15.52 per ton. The placer output reported by 17 operators from surface and drift placers contained $168,512 in gold and 3,232 ounces of silver. The product of both quartz and placer mines had a value of $497,330. In 1911 the deep mines produced from 13,945 tons of ore, including 80 tons of tailings, $423,182 in gold and silver, or an average value of $30.35 per ton, and the placers $137,503 in gold and silver, or a total for quartz mines and placers of $560,685. The principal ore production came from the Big Four, and other producers of note were the White Caps, Durant, Union No. 2, Liberty Fraction, Manhattan Consolidated, Crescent, Union No. 9, and Earl. A description of the mills[1] in the district follows:

With the completion of the Big Four mill during the next two or three weeks, Manhattan will have a daily capacity of 275 tons, affording more abundant facilities for the treatment of ore than any camp of equal size in the State, in keeping with the steadily increasing demands of the mines, and at the lowest average charge for treatment to be found under like conditions anywhere. Manhattan now has three modernly equipped custom mills, each with a daily capacity of 50 tons, taking all ore offered at a charge ranging from $3.50 to $4.50 per ton for hauling and milling, the variation depending upon distance to be hauled and whether the ore is free milling or requires cyaniding to extract the values. The Big Four mill, which is designed for the exclusive treatment of ore from that property, will have a capacity of 125 tons by stamps and amalgamation and will not enter into the competitive markets offered by the other mills.

The War Eagle mill is the oldest of the trio of custom plants, having been erected about five years ago. It is located on Mustang Hill, at the lower end of town, and is equipped for amalgamation and cyanide treatment of ores. It has 10 stamps and a suitable complement of cyanide tanks and other accessories for reducing the crude ore to gold bullion.

The Manhattan Milling & Ore Co. plant, locally known as the "Brady" mill, was constructed about four years ago on Wolftone Hill, across the gulch from the War Eagle, and has similar capacity and equipment. It was tied up by debts and litigation until a year ago, when it was run for several months on ore from the Poak-Steen-Cicala lease on the Big Four. In May the plant was taken over by a Tonopah syndicate.

Ground was broken in November, 1911, for construction of the Associated mill, in the upper end of the camp adjacent to the White Caps, Consolidated, and other properties in that neighborhood. The ores of that section being base and not entirely free milling, the cyanide method, without amalgamation, was installed. A battery of 10 stamps, with tube mill, classifier, and cyanide department give the mill an average daily capacity of 50 tons. The mill was completed and the stamps started dropping on ore April 1, 1912, and the plant has been in continuous and successful operation since that time. The leading interests in the milling company bought the White Caps lease from the original holders a year ago while the mill was under construction, and this lease has supplied most of the ore treated by the mill since it started, although considerable ore from other leases has been handled.

In order to meet the requirements of its mine for milling facilities to treat its ores on the most economical basis, the Big Four Co. began the construction of a mill for its exclusive use about the middle of last November. * * * The mill is located just below the crest of Big Four Hill, with the top of the ore bins on a level with the collar of the shaft, and convenient thereto. From the storage bins the ore will be drawn into a large crusher, then elevated by a belt conveyer to the feed bins above

[1] Manhattan Post, Jan. 4, 1913.

the battery of 10 stamps, and after passing through the stamps the ore will go to 2 tube mills, thence through Akins classifiers, of which there are 2, and finally to 2 amalgamating tables, each 36 feet in length. These tables will be protected by double-locked screens provided with a "master" key, which will be held by the superintendent of the mill, to be used when "clean-ups" are made.

The principal placer production came from the Georgia, Boston, Jumbo No. 2, Mustang Extension, Fairview, Independence, Nemo Extension, Bedrock, Morning Star, Mystery, Midford, Bright August, San Francisco, and Wolftone. Nearly all the placer workings are well equipped for handling the water and gravel, 14 of them having electrically driven pumps and hoists, and quite a number of others using gasoline for power. Whereas a year ago the principal activities were within 2 miles of Manhattan, covering the gulch from the War Eagle mill to a short distance below Central, the center of operations has gradually moved down the gulch to a mile beyond Central, as most of the old "diggings" have nearly been worked out. Thomas "Dry-Wash" Wilson was the leading placer operator during the year as he has been for several years past, employing from 20 to 35 men at his various plants. The pay gravel along the channel carries from $4 to $15 per yard and sometimes more than that, but the general average is about $8 or $9.

The Nevada-California Power Co., which furnishes the power for the mines and mills of the district, the generating plant being 200 miles from Manhattan, at Bishop, Cal., and the branch line leaving the main line at Millers, Nev., 37 miles distant, has proved one of the main factors in the successful development of Manhattan. An average of 8,000 electrical horsepower is used each 24 hours, 35 different operators utilizing electricity. There are 7 air compressors, 14 hoisting plants, and 78 constant-speed motors in use at the present time through the district.

Milletts district.—Production of ore from 3 properties aggregated 188 tons. Some of this ore produced bullion extracted by amalgamation at the National mill. There were also some gold and silver concentrates shipped. The Fluorine and Smoky Valley properties were the principal producers.

Round Mountain district.—Eleven deep-mine operators reported the production of 61,047 tons of ore, from which was recovered $310,812 in gold and 9,370 ounces of silver, with a total value of $316,575, or an average value of $5.19 per ton. The placer bullion reported by 6 producers amounted to $35,392 in gold and 969 ounces of silver. The total value of the district output amounted to $352,563. The richest part of the district output came from the property of the Round Mountain Mining Co. Other producers were the Fairview, Antelope, Blue Jacket, and Sphinx properties.

There were produced from the Round Mountain[1] mine—

57,360 tons on a gross value of $5.56 per ton, or a total gross value of $318,985.46, from which we recovered $4.92 per ton, or a total of $282,335.05, or 88.5 per cent of the gross value of the ore. The total operating cost for the year was $261,374.98, or $4.55 per ton. * * * The total production from the underground crusher station amounted to 6,382 tons of ore of an average value of $4.69 per ton and 16,306 tons of waste rejected, averaging $0.77 per ton. The plant has proven efficient and economical in operation. The ore which was crushed and screened was mined chiefly in the

[1] Ann. Rept. for year ending Mar. 31, 1913.

glory hole near No. 1 plant, but includes some ore derived from development work in 501 crosscut and from various drifts on the 450 sublevel above the crushing plant. The grade of the ore has not been as good as was expected, but the operations have yielded a small profit due to low cost of mining ore in the glory hole. No. 2 plant has been in continuous operation about 11 months out of the year. In December and January it was found necessary to drive a new haulage tunnel, as the slopes of the open cuts had begun to encroach on the old loading tunnel. The plant was completely overhauled during the enforced shutdown and is now in excellent condition. Within the year a gross tonnage of 57,237 was mined, which produced 15,590 tons of ore sent to the mill, of an average value of $7.12 per ton, and 40,589 tons of waste rejected, of an average value of $0.97 per ton. The cost of mining this material is between $0.80 and $1 per ton and the cost of crushing, screening, and transportation, including all repairs and renewals, between $0.05 and $0.06 per ton.

Tonopah district.[1]—The table which follows shows the production of the Tonopah district from 1904 to 1912 inclusive:

Ore sold or treated in Tonopah district, Nye County, Nev., in 1904–1912, number of producers, and total content of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1904	10	22,703	$386,526	2,119,942	.....	.....	$1,594,893
1905	12	91,651	1,206,345	5,369,439	.....	.....	4,449,486
1906	9	106,491	1,304,677	5,697,928	.....	.....	5,122,289
1907	10	214,608	1,183,628	5,370,891	5,939	195,508	4,739,966
1908	13	273,176	1,624,491	7,172,396	.....	.....	5,425,861
1909	9	278,743	1,400,361	7,872,967	1,784	1,488	5,494,600
1910	18	365,139	2,303,702	10,422,869	942	6,902	7,932,475
1911	19	404,375	2,366,495	10,868,268	.....	.....	8,126,677
1912	17	479,421	2,223,878	10,144,987	14	700	8,463,079
Increase (+) or decrease (−) in 1912		+75,046	−142,617	−723,281	+14	+700	+336,402

Seventeen deep mines in 1912 produced 479,441 tons of ore, yielding gold and silver valued at $8,463,079 (the highest value attained in the history of Tonopah), or an average recovery of $17.65 per ton. Nineteen deep mines in 1911 produced 404,375 tons of ore, which was valued at $8,126,677, or an average of $20.10 per ton. The largest part of the ore, or 472,541 tons, was treated at cyanide plants with and without concentration, yielding 88,612.27 ounces of gold, 8,107,086 ounces of silver, and 2,434 tons of concentrates, containing 13,899.98 ounces of gold and 1,596,097 ounces of silver. The average recovery value of the ores milled was $14.43 per ton, and the average value of the concentrate was $521.33 per ton. Crude ores of shipping grade amounted to 6,138 tons, containing 4,706.75 ounces of gold, 409,285 ounces of silver, and a very small quantity of copper and lead, which probably came from an outlying district, valued in all at $349,111, or an average value of $56.88 per ton. The largest productions were made by the following companies which furnished details in printed reports of the year's operations: Belmont, Tonopah Mining, Montana Tonopah, Tonopah Extension, and West End. The Jim Butler, McNamara, North Star, Tonopah Merger, and Midway also made important productions.

[1] Spurr, J. E., Geology of the Tonopah mining district, Nevada: Prof. Paper, U. S. Geol. Survey No. 42, 1905, 295 pp.

On July 20 the new Belmont mill was put in operation and with the old plant treated 128,975 tons of ore from the Belmont mine.[1]

The average value of the ore produced during the year, as compared with the previous three years, is as follows:

	1913	1912	1911	1910
Tons shipped to mill	128,975	87,952	59,159	29,898
Average gross value per ton	$24.21	$20.84	$27.58	$14.40
Tons shipped to smelters	562	27,611	21,907	7,032
Average gross value per ton	$70.71	$61.35	$54.76	$34.89
Total production (dry tons)	129,537	115,563	81,066	36,930
Average gross value per ton	$24.34	$30.51	$34.93	$17.99

The sales of ore, bullion, concentrates, etc., for the year, as compared with the previous year, were divided as follows:

	1913	1912
Gold:		
38,371 ounces, 1913.		
45,069 ounces, 1912.		
Sold for	$793,191.59	$886,971.47
Average per ounce:		
$20.672, 1913.		
$19.68, 1912.		
Silver:		
3,826,399 ounces, 1913.		
4,535,762 ounces, 1912.		
Sold for	2,367,559.59	2,381,542.54
Total	3,160,751.18	3,268,514.01
Less treatment charges, assaying, freight, and express	100,537.52	387,337.26
Total receipts	3,060,213.66	2,881,176.75

The large saving in treatment charges, assaying, freight, and express, amounting to $286,799.74, is due to the fact that very little ore was shipped to smelters, as the New Mill is capable of successfully treating all grades of ore. * * * For the fiscal year covered by this report, the mining cost (including all Tonopah overhead expenses) of $4.621 per ton of ore shipped, shows a decrease of $0.818 per ton over the corresponding cost ($5.439) for the previous fiscal year. The cost per ton of crude ore hoisted was, in the year covered, $3.836, as against $4.118 in the previous period, a decrease of $0.282 per ton. The above costs, including, as they do, all indirect costs, such as taxes and insurance, bullion tax, and especially the purely book account cost depreciation, are of less value as comparative costs than are the direct mining costs. In the year covered by the report the direct mining cost per ton of ore shipped was $4.12, a decrease from the $4.72 of the previous year of $0.60 per ton. * * * The mine product treated by both plants during the year amounted to 127,920 dry tons, averaging 0.287 ounces gold and 29.54 ounces of silver, or $24.21 per ton, the total contained metals in this tonnage aggregating 36,734.968 ounces gold and 3,779,184.32 ounces silver, or $3,096,448.54. Of this, 35,270.447 ounces gold and 3,521,604.28 ounces silver were recovered, the actual extraction being 96.01 per cent gold and 93.18 per cent silver, or a combined actual extraction of 93.98 per cent. This extraction was in excess of the extraction of the previous year by 1.44 per cent. The total milling cost of the mine tonnage treated at both plants during the year was $3.613 per ton, a decrease from the $3.879 per ton of the previous year of $0.266 per ton, this decrease being made up of ($3.130 in 1911 and $2.998 in 1912) and of the decrease in indirect milling cost of $0.134 per ton ($0.749 in 1911 and $0.615 in 1912).

During the first six months of the fiscal year the milling plant at Millers was operated on Belmont mine ores, treating at this time 43,034 tons of ore of an average content in gold of 0.335 ounce and in silver of 34.01 ounces, or an average money value of $27.53 per ton, at a direct cost of $3.17 per ton and an indirect cost of $0.77 per ton, or a total milling cost of $3.94 per ton.

[1]Ann. Rept. Tonopah Belmont Development Co. for year ending Feb. 28, 1913.

During the second half-year period the Millers plant has been run as a custom mill, treating 13,108 tons in the half year, the main sources of this supply having been the Jim Butler-Tonopah Mining Co., the Tonopah Merger Mining Co., and the Tonopah Midway Mining Co. During the operation of the Millers plant as a custom mill the sand treatment has been entirely eliminated and the mill operated as an all slime plant, this method greatly reducing the capacity, but returning a better extraction of the metals.

In addition to the custom ores treated, some 4,217 tons of old sand residues have been treated by regrinding and agitating. These old sand residues, containing but 0.023 ounce gold and 2.72 ounces silver, or $2.17 per ton, could not have been treated alone, and with the recovery of but 65 per cent of the total content, or $1.41 per ton, and with the direct milling costs at $3.17 per ton, would appear to have been worked at a loss. As a matter of fact, however, the cost of treating the sands (already very fine and needing but a little regrinding in the tube mills for sliming) in connection with the ores, is but $0.927 (supplies, $0.508; labor, $0.248, and power, $0.171), so that a profit of $0.483, less the very small marketing bullion charge has accrued from the re-treatment process.

There were mined and milled from the Tonopah Mining Co.[1] property—

173,336 tons of ore, averaging 0.23 ounce of gold and 21.75 ounces of silver, or $18.16 per ton, which is 0.056 ounce of gold and 4.3 ounces of silver, or $1.81 per ton lower than the average of the ore milled during the previous year, when silver averaged $0.07529 per ounce lower.

The total gross contents of the ore milled during the year was 39,825 ounces of gold and 3,769,669 ounces of silver, or a total gross value of $3,148,668.17, of which there were recovered by concentration and shipped to the smeltery 1,027 dry tons of concentrates, averaging 3.907 ounces of gold and 567.07 ounces of silver per ton, or a total content of 4,013.051 ounces of gold and 582,450.59 ounces of silver of a total smelter gross value of $443,503.35.

The cyanide treatment yielded 2,925,733.15 ounces of bullion, containing 32,273.189 fine ounces of gold and 2,785,507.75 fine ounces of silver, or a total smelter gross value of $2,384,631.54.

The slag, instead of being shipped to the smeltery, was concentrated by a jig, the tailings of which were fed into the stamp batteries. Thus the values were recovered in the mill at a cost much less than under the old plan of shipping as a by-product. The other by-products were mixed and shipped with the concentrates. * * * The combined extraction of both gold and silver was 89.34 per cent. Upon comparison with the previous year this shows an increase of 0.88 per cent gold and a decrease of 1.22 per cent silver, or a decrease in both gold and silver of 1.2 per cent. * * * Sand residues discharged from the plant averaged 0.025 ounce gold and 2.76 ounces silver per ton, this being 0.005 ounce gold and 0.38 ounce silver per ton lower than the previous year. * * * Slime residues, amounting to 56 per cent of the ore tonnage treated, averaged 0.017 ounce gold and 1.98 ounces silver per ton, showing a decrease in the quantity of gold discharged from the plant with the residues amounting to 0.009 ounce gold and an increase of 0.01 ounce silver per ton. * * * The average cost to mine and mill the ore and market the products for the past year was as follows:

Mining costs	$3.27
Milling costs	2.67
Freight on ore milled	.74
Marketing mill products	.51
Total costs per ton	7.19
Metal losses in milling and refining	1.85
Profit per ton	9.12
Average gross value of ore milled	18.16

* * * New veins were encountered on the 600-foot level of the Red Plume farther north than any veins hitherto worked in the property, and in the Mizpah trachyte. The first of these encountered yielded a relatively small tonnage, but of universally high grade ore, while the more northerly one is of more considerable width, and is now in progress of development. Six hundred and forty tons of average $30 ore have been produced from the short drift on the vein, and stoping has just been begun.

[1] Ann. Rept. Tonopah Mining Co. of Nevada for year ending Feb. 28, 1913.

Dividends of the Tonopah Mining Co. since April 22, 1905, to April 21, 1913, amount to $10,450,000.

There were mined and milled at the Tonopah Extension property [1] during the year—

54,618.11 tons of ore, containing 957,674.82 ounces of silver and 9,758.585 ounces of gold, or an average of 17.534 ounces of silver and 0.179 ounce of gold per ton. * * * The cost per ton for mining, milling, and marketing the bullion produced was as follows:

Mining costs (including all development work)	$5.331
Milling costs	3.290
Metal losses in milling	.964
Marketing bullion: Express, $0.060; refining, $0.173	.233
Total cost per ton	9.818
Profit per ton	4.651
Gross value of ore milled	14.469

* * * The cost of marketing bullion is $0.233 per ton of ore treated, compared with $0.227, last year's cost. * * * The ore mined during the year came from drifts and stopes on four different veins developed in your property to date, mining being conducted from the 270, 400, 500, 600, and 660 foot levels. * * * The average fineness of the bullion produced was 945.104 in silver and 9.760 in gold.

The Montana-Tonopah mine [2] produced 53,874.08 tons of milling ore, containing gold and silver which was valued at $826,523.98, or an average value per ton of $15.34.

During the latter part of the year two underfeed Trent agitators were installed, and for the last four months the shipment of practically all vanner concentrates was discontinued, it being now treated direct with the mill product, thus saving the shipping and smelter charges. The economic balance between loss in extraction and saving on concentration is still on the side of decreased concentration, and should be more apparent during the coming year, when in operation over a longer period. However, it is expected that during the coming year the cyanide plant will absorb the extra concentrates without suffering in extraction, and a very material saving will be effected. * * * During the year the usual amount of development work was accomplished, showing a total of 10,076 feet, as against 9,932 feet for the preceding year. In addition to this three diamond drill holes were completed, making a total of 1,047½ feet drilled, as compared with 1,086 feet for the preceding year. The greater part of the development work was confined to the southeastern portion of the property, and has resulted in the discovery of several bodies of good ore.

There were mined and milled 44,756 tons of ore from the West End property.[3]

The total recovery of metals was:

Gold	ounces	8,817.561
Silver	do	830,893.66
A gold extraction of	per cent	94.24
A silver extraction of	do	89.02
A total metallic extraction of	do	89.91

Production of West End mine in 1912.

	Gold.	Silver.
	Ounces.	*Ounces.*
758,291 ounces of bullion, containing	8,153.281	682,932.24
22.41 tons slag, containing	22.860	2,964.36
355.21 tons concentrates, containing	641.420	144,997.06
A residue of 44,401 tons tailing	559.524	102,478.30

[1] Ann. Rept. Tonopah Extension Mining Co. for year ending Mar. 31, 1913.
[2] Ann. Rept. Montana-Tonopah Mining Co. for year ending Aug. 31, 1912.
[3] Ann. Rept. West End Consolidated Mining Co. for year ending Mar. 31, 1913.

There was obtained from the metallic contents of the ore:

	Gold.	Silver.
	Per cent.	*Per cent.*
By cyanidation	87.38	73.49
By concentration	6.85	15.53
Lost in tailing	5.77	10.98

* * * The direct milling costs for the year were $3.288 per dry ton, and the indirect $0.341. During the year the tonnage treated per day was increased from 102 tons for the first quarter to 145 tons for the last quarter. To accomplish the increase and to treat the higher grade of ore it was necessary to add a concentrating addition and to make many minor changes and additions to the equipment of the mill.

From the Midway mine [1] 694 tons of ore were produced, valued at $20,924.79, or an average value per ton of $30.15. The mine is developed by 2 shafts 850 and 330 feet deep.

Union district.—Four operators reported the production of 7,395 tons of ore and tailings, yielding $9,940 in gold and 7,180 ounces of silver, valued in all at $14,356. The largest part of the output came from the old tailings treated on the Blue Bell property by the cyanide process. The Catherine and Gold Eagle groups were also producers of bullion, extracted from ore treated at the Berlin mill.

ORMSBY COUNTY.

Five deep-mine producers reported the mining of 859 tons of ore, which is 868 tons less than was mined by the same number of operators in 1911. The total average value per ton decreased from $13.08 in 1911 to $11.86 in 1912, and the gold and silver value decreased from $12.97 to $11.82 per ton. Only 3 tons of ore were reported as shipped directly to smelters. The gold and silver bullion is estimated to have been produced from 836 tons of old tailings, which were recovered by dredge and sluicing operations below the old mills erected along Carson River during the early Comstock mining.

STOREY COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Storey County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	34	95,894	$977,349	618,006	.....	.....	$1,304,892
1912	30	112,001	855,494	806,853	1,322	3,612	1,352,089
Increase (+) or decrease (−) in 1912		+16,107	−121,855	+188,847	+1,322	+3,612	+47,197

[1] Ann. Rept. Tonopah Midway Mining Co. for year ending Dec. 31, 1912.

The ore mined by 30 producers aggregated 112,001 tons, which includes some old tailings re-treated. The total output was 16,107 tons more than was produced in 1911 by 34 producers. The total average value of the ore decreased from $13.61 in 1911 to $12.07 in 1912. The value was entirely for the gold and silver. The larger part of the production, or 107,749 tons, was treated by the amalgamation and cyanidation processes, yielding $489,865 in gold and 404,436 ounces of silver, valued in all at $738,593, or an average value of $6.85 per ton. There were also 649 tons of old tailings re-treated, yielding gold and silver. At gold and silver mills some concentrates were produced, which, with those produced at concentration plants, aggregated 1,924 tons and contained $320,125 in gold, 195,508 ounces of silver, with small values in copper and lead, valued in all at $440,743 or $229.07 per ton. Crude ore shipped aggregated 916 tons, containing $45,092 in gold, and 206,136 ounces of silver, valued in all at $187.62 per ton.

Comstock district.[1]—Ore and old tailings aggregated 112,001 tons reported by 30 producers in 1912, having a total value of $1,352,089. This is 16,107 tons greater than was mined in 1911 by 34 producers. The larger part of the production, or 107,749 tons, was treated at gold and silver mills and produced 23,697.17 ounces of gold and 404,436 ounces of silver. There were also some concentrates produced at gold and silver mills, which, added to the concentrates produced at concentration plants, aggregated 1,924 tons and contained 15,486.02 ounces of gold, 195,508 ounces of silver, 1,322 pounds of copper, and 3,612 pounds of lead. Ore of shipping grade aggregated 916 tons and contained 2,181.33 ounces of gold and 206,136 ounces of silver. The principal producers were the Belcher Silver, Chollar, Comstock Phoenix, Crown Point, East Comstock, Hale & Norcross, Justice, Lady Bryan, Mexican, Monte Cristo, Ophir, Consolidated Virginia, Potosi, Silver Hill, and Yellow Jacket.

In 1912 the Mexican mine produced 20,000 tons of $23 ore, containing gold and silver, which was extracted by the cyanide process in its new mill completed early in the year. The Ophir 100-ton cyanide plant was completed in October and a short run was made on accumulated tailings for which the mill was designed.

The early production of the Consolidated Virginia mines [2] is given as follows:

[1] Becker, G. F., Geology of the Comstock lode and the Washoe district, with atlas: Mon. U. S. Geol. Survey, vol. 3, 1882, 422 pp.

[2] McCormick, T. F. [Supt.], Report upon proposed exploration on the upper levels, Jan. 5, 1913.

Production of gold and silver combined from the Consolidated Virginia and California mines, and amount of dividends paid from 1873 to 1881, inclusive.

Year.	Quantity of ore.	Gold and silver bullion.		Dividends.
		Total value.	Average value recovered.	
	Short tons.		*Per ton.*	
1873	8,608	$645,582.17	$75.00	.....
1874	66,420	4,981,484.05	75.00	$2,592,000
1875	174,217	17,184,713.89	98.60	11,448,000
1876	271,478	30,062,782.10	110.70	21,600,000
1877	361,832	32,658,869.34	90.40	22,680,000
1878	257,708	18,945,832.04	73.60	12,420,000
1879	124,379	5,058,854.00	40.65	2,970,000
1880	93,016	2,647,051.82	28.50	540,000
1881	12,618	266,171.36	21.10	.....
Total	1,370,276	112,451,340.77	82.07	74,250,000

1873: Bullion production for 1873–74 is official, but not having the average recovery, have assumed $75 and derived an approximate tonnage by division.

1874: Previous to 1875 the production had come from the 1,200 and 1,300 levels and from exploration work on the 1,400.

1875: Consolidated Virginia: Ore from 1,200, 1,300, 1,400, and 1,500. California: Development on 1,300, 1,400, 1,500, and 1,550.

1876: Consolidated Virginia: Ore extracted from 1,300, 1,400, 1,500, and 1,550. California: Exploration 14 and 16; principal extraction from 1,500 and 1,550.

1877: Consolidated Virginia: More ore encountered on 1,200 and 1,300; stoping on 1,400, 1,500, and 1,550; development work on 1,650 and 1,750. California: Exploration on 1,400, 1,650, 1,700, 1,750, 1,840; production from 1,500, 1,550, and 1,600.

1878: Consolidated Virginia: Production from 1,200, 1,400, 1,500, 1,600; exploration, 1,750, 1,850. California: 1,500 and 1,550 about exhausted; main production from 1,600 and 1,650; development on 1,700, 1,750, and 1,840; exploration on 1,950 and 2,150.

1879: Consolidated Virginia: Production from 1,400, 1,500, 1,650, 1,750, 1,850, and 1,950; exploration, 850 and 2,150. California: Production from 1,650, 1,750, 1,840, 1,950, 2,150; exploration, 850, 2,250, and 2,350.

1880: Consolidated Virginia: Production from 1,650 and 1750; exploration on 2,150, 2,350, and 2,450. California: Production from 1,500, 1,650, 1,750, 2,150; exploration on 2,350, 2,450, and 2,650.

1881: Consolidated Virginia: Production from 1,650 and 1,750; exploration, 2,450 and 2,650; stope fires interfered seriously with operation. California: Production from 1,650, 1,750, and 2,250; exploration on 2,456 and 2,650; stope fires.

From 1873 to 1881, inclusive, Consolidated Virginia produced 776,265 tons of ore, from which bullion recovery averaged $83.91 per ton and totaled $65,133,391.95, from which dividends amounting to $42,930,000 were paid.

In the same period the California produced 594,013 tons of ore, from which the bullion recovery averaged $76.66 per ton and totaled $47,317,948.82, from which dividends amounting to $31,320,000 were paid.

From the two mines together the total production was 1,370,276 tons, from which the average bullion recovery was $82.07 and the total recovery $112,451,340.17, from which dividends amounting in all to $74,250,000 were paid.

It should be noted in passing, however, that the stated bullion production is extremely misleading, as it gives much less than full credit to the Bonanza; for the average extraction reported in the last six years of the period is less than 74 per cent, and it is not probable that there was as high an extraction in the three previous years, during which Consolidated Virginia produced $22,000,000. If for a rough estimation we call the extraction 75 per cent, it appears that one-third as much as the value of the bullion produced, or $37,483,700, fell to the milling company as a tailings perquisite, and a large proportion of this was recovered by that company in further treatment of the tailings.

The tailings thus appear to have averaged at least $27 and, after being worked by the original milling company to a grade of, perhaps, $7, they were reworked. It may be assumed with safety that there are none of them left with an average value in excess of $4. On this assumption the ultimate bullion production from the ore under consideration was probably $31,500,000 more than appears in the tables. It can, in short, hardly be doubted that the ore produced in the Bonanza period has yielded bullion to a value of $144,000,000 instead of $112,000,000, as was commonly supposed, and the total production of bullion from the mine to date has thus been about $165,000,000 instead of $133,500,000, popularly attributed to it. A just conception of these figures can best be had by comparison, and so I may mention that while the 1,310 feet of the lode belonging to us have yielded $165,000,000 and paid over $78,000,000 in dividends, a recent publication attributes to the whole camp of Tonopah since 1901 a production of but $51,000,000 and dividends somewhat in excess of $15,000,000.

Production during period of the reworking of the old stopes 1882–1897, inclusive.

Year.	Quantity of ore.	Gold and silver bullion.		Dividends.
		Total value.	Average value recovered.	
	Short tons.		*Per ton.*	
1884 [a]				
1885	38,929	$640,463.97	$16.45	
1886	109,205	1,482,624.88	13.57	
1887	125,876	3,523,930.04	27.09	
1888	148,303	4,060,978.78	27.24	
1889	136,189	3,327,281.90	24.43	
1890	119,315	2,255,946.24	18.90	
1891	86,443	1,749,305.02	20.23	
1892	53,421	974,341.89	18.23	
1893	25,613	524,196.74	20.46	
1894	7,100	362,793.66	51.09	
1895	10,255	491,807.64	47.96	
1896	7,059	211,333.49	29.93	
1897	3,234	106,332.95	32.80	
Total	870,942	19,711,337.20	22.63	$3,898,000
SUMMARY.				
1873 to 1881	1,370,276	112,451,340.77	82.07	74,250,000
1882 to 1897	870,942	19,711,337.20	22.63	3,898,000
Total	2,241,218	133,162,677.97	59.41	78,148,000

[a] Consolidated Virginia and California were consolidated Nov. 1, 1884.

WASHOE COUNTY.

Production was reported from 43 deep mines in 1912, against 34 in 1911. The yield of ore aggregated 2,689 tons, which is 1,294 tons less than was produced in 1911. The average value per ton increased from $18.59 in 1911 to $24.10 in 1912, while the gold and silver values in this ore remained about the same, there being only a small variation. Most of the ore mined (2,069 tons) was treated in gold and silver mills, yielding $41,729 in gold and 857 ounces of silver, valued in all at $42,256, or an average value of $20.42 per ton. Some of the ore treated at the milling plants yielded lead concentrates. There were mined and shipped to smelters 611 tons of ore, containing $983 in gold, 7,547 ounces of silver, 83,439 pounds of copper, and 36,971 pounds of lead, valued in all at $21,055, or an average value of $34.46 per ton. The placer production amounted to $128 in gold and 3 ounces of silver.

Leadville district.—From 2 properties in the district 927 tons of ore were produced, the larger part of which was treated at a gold and silver mill, producing bullion. There was also a small tonnage of crude ore, containing lead, shipped to the smelter. The producers were the Donnelly Mountain and Belle of the West properties, and some ore was shipped from the Tehoqua mine.

Peavine district.—Numerous small properties, including the Red Metals, yielded 510 tons of shipping ore, which contained $863 in gold, 3,563 ounces of silver, 74,950 pounds of copper, valued in all at $15,421, or an average of $30.24 per ton.

White Horse district.[1]—There were 1,103 tons of ore reported as mined from several properties in the district by 24 producers. The

[1] Hill, J. M., Notes on the economic geology of the Ramsey, Talapoosa, and White Horse mining districts in Lyon and Washoe counties, Nev.: Bull. U. S. Geol. Survey No. 470, 1911, pp. 99–108.

entire production was treated at milling plants and yielded 1,485.79 ounces of gold, 547 ounces of silver, and 18 tons of lead concentrates, containing gold and silver. Among the producers were the Emma, Mizpah, Green Hill, Crown Point, Renegade, Springfield-Nevada, and Golden Eagle.

WHITE PINE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in White Pine County, Nev., in 1911 and 1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1911	25	2,778,607	$446,409	122,685	67,035,361	572,654	$8,916,621
1912	21	3,024,588	[a] 483,503	[a] 97,128	67,380,536	1,015,990	11,706,745
Increase (+) or decrease (−) in 1912		+245,981	+37,094	−25,557	+345,175	+443,336	+2,790,124

[a] Includes small placer production.

The ore mined aggregated 3,024,588 tons. This is the largest tonnage ever mined in any county in the State, and is 245,981 tons more than was produced in 1911. There were 20 deep-mine producers reporting in 1912, against 25 in 1911. The total average value of the ore increased from $3.21 in 1911 to $3.87 in 1912, and the gold and silver value, which was 18 cents in 1911, remained the same in 1912. The bulk of the ore, or 2,985,217 tons, was treated at concentration plants and yielded 329,588 tons of concentrates, which contained $461,492 in gold, 75,496 ounces of silver, 64,932,446 pounds of copper, and 12,452 pounds of lead, valued in all at $11,222,336, or an average value of $34.05 per ton. These concentrates were almost entirely smelted at the Steptoe Valley works at Ely. There was also smelted an important tonnage of crude ore, containing copper, while that containing lead was shipped to outside smelters. The ore of shipping grade aggregated 38,914 tons and contained $14,683 in gold, 21,488 ounces of silver, 2,448,090 pounds of copper, and 1,003,538 pounds of lead, having a total vlaue of $476,992, or an average value of $12.26 per ton.

Cherry Creek district.—Two producers reported the production of 136 tons of lead sulphide ore, containing copper and silver, amounting in value to $2,371.

Duck Creek district.—Six deep-mine operators reported the production of 692 tons of ore, the larger part of which, or 567 tons, was shipped directly to the smelters and contained 12.13 ounces of gold, 4,408 ounces of silver, 2,183 pounds of copper, and 610,012 pounds of lead. Gold and silver bullion is estimated to have been recovered from 125 tons of ore treated at one mill in the district. The producers were the Ely Gibralter, Cuba, Lead King, and Lead Queen properties.

Eagle district.—An important tonnage of lead ore, containing gold and silver, was produced from the Red Hills property.

Osceola district.[1]—From the treatment of 332 tons of ore at gold and silver mills, there was produced 233.42 ounces of gold, 104 ounces

[1] Weeks, F. B., Geology and mineral resources of the Osceola mining district, White Pine County, Nev.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 117–133.

of silver, and 3 tons of concentrates, containing gold and a small quantity of lead and copper.

Robinson (Ely) district.—The following table shows the production of Robinson or Ely district from 1908 to 1912:

Ore sold or treated in Robinson district, White Pine County, Nev., total content of gold, silver, copper, and lead, and number of producers in 1908–1912.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1908	6	430,031	$94,443	30,381	14,797,295	2,381	$2,063,888
1909	10	1,671,225	370,569	79,487	57,481,515	524,512	7,907,053
1910	10	2,375,032	423,225	108,000	63,914,197	180,407	8,606,586
1911	4	2,776,930	435,287	104,107	67,033,547	10,216	8,870,118
1912	5	3,023,082	474,436	78,020	67,373,510	12,168	11,639,595
Increase (+) or decrease (−) in 1912		+246,152	+39,149	−26,087	+339,963	+1,952	+2,769,477

The Nevada Consolidated Copper Co., operating with steam shovels its Eureka and Liberty pits, was the largest producer. An important tonnage was also mined from the Giroux property and treated in the Steptoe concentrator and smelting plant. There was some ore produced from the Phoenix and Butcher Boy properties, part of which was treated at that plant and part shipped to Salt Lake smelters. Considerable delay in the operation of the Nevada Consolidated and Giroux mines was caused by a strike in sympathy for the strikers at Bingham, Utah.

The Nevada Consolidated mine [1] was operated by steam shovel and underground mining—

the first in the three pits—namely, the Eureka, Hecla, and Liberty, and the second in the Veteran mine. The three pits above mentioned are really in one ore body—the Hecla representing a narrower and poorer tongue of ore, connecting the east and west portions of the ore body—the latter two having been determined first and the connection being located at a later period. As has been the case in the past, the Eureka furnished the larger tonnage.

During the fiscal year the following dry tons of sulphide ore were mined and shipped to the concentrator:

	Tons.	Percentage of copper.
Eureka pit	2,054,758	1.603
Liberty pit	170,748	
Hecla pit	371,485	
Veteran mine	253,365	2.605
	2,850,356	1.690

The ore mined was of lower grade than for the preceding year, due to the fact that ore from a greater depth, and therefore poorer, was mined in the Eureka pit, and also ore was mined for the first time from the Hecla area—a much lower grade section than either of the other two.

Siliceous carbonate ore amounting to 88,428 dry tons and averaging 2.78 per cent copper was mined, of which 35,216 tons were crushed and delivered to the smelter and 53,212 tons were put into storage at the mine. * * *

[1] Ann. Rept. for year ending Dec. 31, 1912.

Including charges of every description, such as labor, supplies, repairs, management, taxes, proportion of general and New York expenses, etc., the direct mining costs for Copper Flat ore have been 17.35 cents per dry ton. This shows some increase over previous years, due mainly to the strike, which began in the latter part of September and caused a cessation of work in the mines until October 25. Even after this, it took some weeks before the force was again on a full working basis. Including redemption of stripping, the costs show a very decided increase, due to the fact that a considerable amount of ore was taken from the Liberty and Hecla pits, which entail a greater cost to cover stripping redemption than in the case of the Eureka pit—the latter being 15 cents per ton of ore, the Liberty 22 cents, and the Hecla 30 cents. Including Veteran ore, where the ore is mined underground, the total costs for mining were 33.04 cents per dry ton.

Stripping costs have been reduced to 33.64 cents per cubic yard. The cost of mining carbonate ore was 68.8 cents per dry ton, as compared to 74.4 cents for the preceding year. * * *

The results of the year 1912 were as follows:

Ore treated (dry)	tons	2,852,515
Average copper assay	per cent	1.692
Percentage of extraction (copper)		68.25
Ratio of concentration		9.09
Assay value in gold	ounces	0.016
Assay value in silver	do	0.49
Percentage of extraction (gold)		45.84
Percentage of extraction (silver)		50.11
Average gold and silver recovered per ton ore in cents		16.48
Average copper in concentrates	per cent	10.49

The yield from all ore mined and treated and from siliceous carbonate ore delivered to the smelter has amounted to 63,063,261 pounds of copper for the year 1912.

The total cost per pound of copper has been 8.86 cents, and deducting miscellaneous earnings, but including fund to cover improvements and depreciation, this is reduced to 8.33 cents. These costs include all possible charges, such as costs in Nevada, shipping, refining, marketing, legal expenses, taxes, New York expenses, etc.

Shipments of concentrating ore were made to the Steptoe smelter from the Giroux mine[1] beginning May 1. The production gradually increased until a maximum of 1,200 tons of ore per day from the mine and the old stock piles was attained, and 140,877 tons, averaging 2.15 per cent of copper, were mined. In addition to the above, shipments to the smelter were made of 179.6 tons of Taylor ore, averaging 4.27 per cent of copper, 0.10 ounce of gold, 0.93 ounce of silver. Of Alpha ore shipments, 78 tons averaged 9.38 per cent of copper and 152 tons averaged 8.16 per cent of copper. The milling ore aggregating133,933 tons, averaging 1.97 per cent of copper, yielded 71.1 per cent of its copper content by concentration. The concentrates yielded at the smelter 2,862 ounces of silver, 1,214.065 ounces of gold, and 3,768,521 pounds of copper.

Silverado district.—The Washington mine produced lead sulphide ore, containing some copper, silver, and gold.

White Pine district.—All of the ore produced in this district by 2 operators contained lead, gold, and silver, and was of shipping grade. The Dog Star, the principal producer, was operated by lessees.

[1] Ann. Rept. Giroux Consolidated Mines Co. for year ending Dec. 31, 1912.

NEW MEXICO.[1]

By Charles W. Henderson.

PRODUCTION.

The value of the production of gold, silver, copper, lead, and zinc in New Mexico for 1912, as reported from 145 productive mines, 26 of which were placers, amounted to $8,527,955. As compared with $2,704,843 in 1911, this shows an increase in value for 1912 of $5,823,112. The gold yield was 37,947.57 fine ounces, valued at $784,446, an increase in 1912 of 1,046.73 fine ounces in quantity and of $21,638 in value. The silver yield was 1,536,701 fine ounces, an

[1] The publications of the United States Geological Survey mentioned in the following list may be obtained free by applying to the Director, United States Geological Survey, Washington, D. C., except those to which a price is affixed; they can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

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increase of 182,161 fine ounces in quantity and of $227,165 in value. The copper output was 34,030,964 pounds, an increase in 1912 of 29,973,924 pounds; the lead output was 5,494,018 pounds, an increase of 2,527,796 pounds, and the zinc output was 13,566,637 pounds, an increase of 3,329,461 pounds. The value of the base metals showed an increase of $5,107,979 for copper, $113,751 for lead, and $352,579 for zinc.

There were 1,352,286 short tons of ore sold or treated in 1912, which averaged $6.29 in value per ton, as compared with 232,699 short tons, averaging $11.54 per ton in 1911; with 191,865 short tons, averaging $13.89 in 1910; with 164,156 short tons, averaging $12.48 in 1909; with 135,434 tons, averaging $11.09 in 1908; and with 219,992 tons, averaging $14.64 in 1907. The output of copper ores, of lead ores, and of zinc ores increased; the output of siliceous or dry ore, of copper-lead ores, and of lead-zinc ores decreased; and the total ore output increased 1,119,587 tons. The average recovered value per ton in 1912 in gold and silver was $11.24 in siliceous ore, $0.275 in copper ores, $7.115 in lead ores, $6.17 in copper-lead ores, and $1.21 in lead-zinc ores.

During 1912 there were treated at amalgamating and cyaniding mills in New Mexico 106,208 tons of ore, and the bullion saved amounted to $420,518 in gold, an average value per ton of $3.959, and 842,018 ounces of silver, valued at $517,841, an average recovery per ton of 7.928 ounces, and an average value of $4.876, the value in gold and silver being $938,359, an average value per ton of $8.835. The recovery as bullion per ton of ore treated in 1911 was $4.147 in gold and $3.745 in silver, a total of $7.89, showing for 1912 an average decrease of $0.0188 per ton in gold and an average increase of $1.131 per ton in silver recovered as bullion.

From 1,142,002 tons treated at mills by concentration or magnetic separation there were produced 81,811 tons of concentrates (ratio 13.9 to 1), valued at $148,643 in gold, an average per ton of $1.82, and 290,081 ounces of silver, valued at $178,400, an average per ton of $2.18, the value in gold and silver being $327,043, with an average of $4 per ton. For those concentrates which carried copper (however little) the average assay was 19.75 per cent; for those concentrates which carried lead the average assay was 19.32 per cent; for zinc concentrates the average assay of zinc content was 37 per cent.

From the 1,248,210 tons crushed in all classes of mills there were produced $569,161 in gold from both bullion and concentrates, at an average recovery of $0.456 per ton, and $696,241 in silver, at an average recovery of $0.557 per ton, a recovery in both gold and silver of $1,265,402, at an average of $1.01 per ton in these two metals for all ore milled. The average value in gold and silver recovered in 1911 from 168,735 tons milled was $7.12 per ton, a decrease for 1912 of $6.11 per ton; the average in 1910 from 128,527 tons milled was $5.82; and the average in 1909 from 111,612 tons milled was $2.86.

Crude ore shipped to smelters amounted to 104,076 short tons, containing $198,359 in gold, averaging $1.91 (or 0.092 ounce) per ton; 404,462 ounces of silver, valued at $248,744, averaging 3.885 ounces, or $2.39 per ton, the value in both gold and silver being $447,103, and the average per ton $4.30, as compared with $4.06 in 1911. Crude ore to smelters also contained 5,270,056 pounds of copper, averaging 2.53 per cent, and 3,509,583 pounds of lead, averaging 1.69 per cent. Much of this ore carried neither copper nor lead; that which carried copper averaged 2.92 per cent of that metal; that which carried lead averaged 9.09 per cent; that which carried zinc averaged 34.9 per cent.

Mine production of gold, silver, copper, lead, and zinc in New Mexico from 1904 to 1912, inclusive.

Year.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	102,339	$381,930	214,553	4,972,170	3,122,872	13,493,835	$1,961,390
1905	145,629	317,510	369,192	6,126,025	1,510,209	15,142,254	2,460,535
1906	207,691	293,019	491,127	7,028,670	2,987,369	17,292,655	3,203,739
1907	219,992	329,982	705,544	10,990,015	3,809,881	750,085	3,239,823
1908	135,434	298,757	405,044	6,112,630	873,763	3,576,516	1,525,091
1909	164,156	239,491	397,783	5,393,146	5,029,767	13,085,945	2,070,368
1910	191,865	482,424	843,987	4,614,386	4,320,841	18,088,129	2,691,080
1911	232,699	762,808	1,354,540	4,057,040	2,966,222	10,237,176	2,704,843
1912	1,352,286	784,446	1,536,701	34,030,964	5,494,018	13,566,637	8,527,955
Increase	1,119,587	21,638	182,161	29,973,924	2,527,796	3,329,461	5,823,112

[a] Includes placer production.

Tonnage of ore sold or treated, number of deep mines producing, by counties, and average value per ton of ore mined in New Mexico in 1911 and 1912.

County.	Short tons of ore sold or treated.		Number of deep mines producing.	
	1912	Increase (+) or decrease (−).	1911	1912
Colfax	3,025	+ 719	3	2
Dona Ana	78	+ 73	2	4
Grant	1,200,691	+1,106,921	42	57
Lincoln	2,003	+ 425	3	7
Luna	3,090	+ 2,861	8	13
Otero	3,792	+ 2,696	6	4
Sandoval		− 10	1	
Santa Fe	15,335	+ 15,215	3	2
Sierra	252	− 4,784	7	11
Socorro	124,020	− 4,529	10	19
Total	1,352,286	+1,119,587	85	119
Average value per ton			$11.54	$6.29

GOLD.

The gold production of New Mexico in 1912 amounted to 37,947.57 fine ounces, valued at $784,446, as against 36,900.84 fine ounces, valued at $762,808, in 1911, an increase of 1,046.73 fine ounces in quantity and of $21,638 in value. Socorro County alone produced 25,427.30 fine ounces, valued at $525,629, or 67 per cent of the total gold yield. This was almost entirely from the siliceous ore mines at Mogollon. There were small increases in the gold yields of Grant, Luna, Otero, and Santa Fe counties, chiefly from siliceous, copper, and lead ores. Siliceous ore furnished in the whole State 29,503.13 fine ounces, valued at $609,884, or 77.75 per cent of the total; copper ores contained 7,284.74 fine ounces of gold, valued at $150,589, or 19.2 per cent of the total, chiefly from Grant and Santa Fe counties. Placer gold amounted to 818.79 fine ounces, valued at $16,926, or 2.16 per cent of the total. The gold in lead, copper-lead, and lead-zinc ores was negligible.

Source of gold production in New Mexico, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placer mines.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ores.	Lead ores.	Copper-lead ores.	Lead-zinc ores.	
Colfax	405.62	1,321.41					1,727.03
Dona Ana				0.82			.82
Grant	123.41	1,453.46	6,453.34	9.53			8,039.74
Lincoln	48.76	1,035.61					1,084.37
Luna				275.11			275.11
Otero	98.39	249.51	282.86				630.76
Rio Arriba	4.84						4.84
Santa Fe	62.98		493.81			0.39	557.18
Sierra	74.79	53.13	53.52	18.98			200.42
Socorro		25,390.01	1.21	5.16	3.43	27.49	25,427.30
Total, 1912	818.79	29,503.13	7,284.74	309.60	3.43	27.88	37,947.57
Total, 1911	905.29	33,035.23	2,920.69	8.04	17.59	14.00	36,900.84
Increase (+) or decrease (−)	−86.50	−3,532.10	+4,364.05	+301.56	−14.16	+13.88	+1,046.73

SILVER.

The silver yield of New Mexico in 1912 amounted to 1,536,701 fine ounces, valued at $945,071, as compared with 1,354,540 fine ounces, valued at $717,906, in 1911, an increase for 1912 of 182,161 fine ounces in quantity and of $227,165 in value. Of the total, Socorro County produced 1,126,429 fine ounces, or 73 per cent, chiefly from siliceous ore from the Mogollon district. Grant County furnished 356,057 fine ounces, or 23 per cent of the total, chiefly from siliceous, copper, and lead ores, with a small quantity from zinc ores and placers. The yield of silver from Grant and Socorro counties combined was over 96 per cent of the total.

Siliceous ore, chiefly from Grant and Socorro counties, furnished 1,141,786 fine ounces of silver, or 74.3 per cent of the total; copper ores, chiefly from Grant County, furnished 290,568 fine ounces, or 19 per cent; lead ores, chiefly from Grant and Luna counties, furnished 68,936 ounces, or 4.5 per cent; copper-lead ores, from Dona

Ana, Lincoln, and Socorro counties, furnished 3,874 ounces, or 0.25 per cent; and lead-zinc ores, from Santa Fe and Socorro counties, furnished 30,220 ounces, or 2 per cent of the total.

Source of silver production in New Mexico, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placer mines.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Colfax	76	558	.....	.....	.....	.....	.....	634
Dona Ana	.....	.....	1	1,224	.....	565	.....	1,790
Grant	39	43,893	274,334	36,624	1,167	.....	.....	356,057
Lincoln	5	117	4	37	.....	842	.....	1,005
Luna	.....	.....	.....	24,265	.....	.....	.....	24,265
Otero	14	278	815	.....	.....	.....	.....	1,107
Santa Fe	4	.....	13,134	.....	.....	.....	1,040	14,178
Sierra	2	3,782	1,735	5,717	.....	.....	.....	11,236
Socorro	.....	1,093,158	545	1,069	.....	2,467	29,190	1,126,429
Total, 1912	140	1,141,786	290,568	68,936	1,167	3,874	30,230	1,536,701
Total, 1911	162	1,183,265	108,892	21,537	.....	4,814	35,870	1,354,540
Increase (+) or decrease (−)	−22	−41,479	+181,676	+47,399	+1,167	−940	−5,640	+182,161

COPPER.

In 1912 the copper output of New Mexico amounted to 34,030,964 pounds, valued at $5,615,109, an increase of 29,973,924 pounds, as compared with the output of 1911. Grant County, chiefly from the Central district (near Santa Rita, Hanover, and Fierro) and the Lordsburg district, produced 32,952,133 pounds in 1912, or nearly 97 per cent of the total. The output from Grant County was 29,033,205 pounds more than in 1911. Other increases were in Colfax, Dona Ana, Lincoln, Otero, Santa Fe, and Sierra counties. Santa Fe County, which ranked second to Grant County in yield of copper in 1907, with no copper output in 1908, with a very small yield in 1909, 1910, and 1911, again ranked second to Grant County in 1912, with an output of 810,563 pounds, an increase, as compared with 1911, of 793,919 pounds. Socorro County's copper output was 89,776 pounds, chiefly from a small tonnage of crude copper ore and from a small content of copper in lead ore and lead concentrates from the lead-zinc ores of the Magdalena district.

Copper ores of Dona Ana, Grant, Lincoln, Sierra, and Socorro counties furnished 33,528,958 pounds, or 98.5 per cent of the total; siliceous, or dry ore (chiefly from the siliceous ore of Lordsburg district, Grant County), furnished 395,552 pounds, or 1 per cent; lead ores, chiefly from Central, Chloride Flat, and Pinos Altos districts of Grant County and the Magdalena district of Socorro County yielded 8,724 pounds; the lead-zinc mines of Magdalena, Socorro County, and the Cerrillos district, Santa Fe County, furnished 44,676 pounds; copper-lead ores, chiefly from Socorro County, furnished 40,308 pounds; zinc ores, from Grant County, furnished 12,746 pounds.

There were 5,270,056 pounds of copper contained in crude ore shipped to smelters, representing 15 per cent of the total, and concentrates carried 28,760,908 pounds, or 85 per cent.

Source of copper production in New Mexico, by kind of ore, in 1912, by counties, in pounds.

County.	Dry or siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Colfax	6,243						6,243
Dona Ana		586	690		5,409		6,685
Grant	375,146	32,559,827	4,414	12,746			32,952,133
Lincoln		1,651	351		7,986		9,988
Otero	13,070	133,518					146,588
Santa Fe		801,893				8,670	810,563
Sierra	909	7,999	80				8,988
Socorro	184	23,284	3,189		26,913	36,006	89,776
Total, 1912	395,552	33,528,958	8,724	12,746	40,308	44,676	34,030,964
Total, 1911	697,634	3,240,693	15,487		36,328	66,898	4,057,040
Increase (+) or decrease (−)	−302,082	+30,288,265	−6,763	+12,746	+3,980	−22,222	+29,973,924

LEAD.

Lead production increased from 2,966,222 pounds in 1911 to 5,494,018 pounds in 1912. The total output in 1912 was valued at $247,231.

The principal lead-producing districts were the Central district, Grant County; the Magdalena district, Socorro County; and the Victorio district, Luna County. Grant County produced 2,309,732 pounds, Socorro County yielded 2,193,178 pounds, and Luna County, 827,556 pounds. Concentrates produced in 1912 contained 1,984,435 pounds of lead, and crude ore sent to smelters contained 3,509,583 pounds.

Lead ores furnished 3,107,561 pounds of lead, and lead-zinc ores, 1,982,638 pounds, the combined content representing nearly 93 per cent of the lead production. Copper ores yielded 3.25 per cent, and copper-lead ores yielded 3.21 per cent of the total.

Source of lead production in New Mexico, by kinds of ore, in 1912, by counties, in pounds.

County.	Dry or siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Dona Ana			17,750		8,379		26,129
Grant	9,776	178,937	2,119,608	1,411			2,309,732
Lincoln			6,482		97,429		103,911
Luna			795,165	32,391			827,556
Santa Fe						12,511	12,511
Sierra	4,698		16,303				21,001
Socorro	386		152,253		70,412	1,970,127	2,193,178
Total, 1912	14,860	178,937	3,107,561	33,802	176,220	1,982,638	5,494,018
Total, 1911	38,365	4,915	1,213,014		152,835	1,557,093	2,966,222
Increase (+) or decrease (−)	−23,505	+174,022	+1,894,547	+33,802	+23,385	+425,545	+2,527,796

ZINC.

The total recoverable zinc, whether marketed as spelter or oxide, from crude ore and concentrates (or separation products), figured in terms of spelter, and zinc in zinc oxide, shipped from New Mexico in 1912 was 13,566,637 pounds, valued at $936,098. In 1911 the out-

put was 10,237,176 pounds, valued at $583,519. In terms of marketable metal, the value of the zinc contained in ore from New Mexico in 1912 was slightly less than the silver output and $151,652 more than the gold output.

Mines producing zinc in New Mexico are at Kelly, Socorro County; in Cooks, Tres Hermanas, and Victorio districts, Luna County; in Central and Pinos Altos districts, Grant County; and at Cerrillos, Santa Fe County.

The ore from the Central district, Grant County, and from Luna County is shipped crude, that from Pinos Altos district, Grant County, and from Santa Fe County is concentrated, and that from Socorro County is in part shipped crude and in part separated magnetically and by wet milling.

Zinc ore and concentrates as marketed, in New Mexico, in 1912, by classes of ore, in short tons, and average assay of zinc.

Character.	Quantity.	Average assay.
Carbonate	11,761	34.9
Concentrates	10,227	37.0
Total	21,988	35.9

Source of zinc production in New Mexico, by kinds of ore, in 1912, by counties, in pounds.

County.	Zinc ores.	Lead-zinc ores.	Total.
Grant	3,135,000	.....	3,135,000
Luna	458,594	.....	458,594
Santa Fe	.....	10,565	10,565
Socorro	4,429,767	5,532,711	9,962,478
Total, 1912	8,023,361	5,543,276	13,566,637
Total, 1911	2,204,029	8,033,147	10,237,176
Increase (+) or decrease (−)	+5,819,332	−2,489,871	+3,329,461

SMELTERS.

The bulk of the smelting lead and copper ores and concentrates continued to be shipped to the El Paso (Tex.) smelter. Some ore and concentrates were shipped to Pueblo, Colo. Copper ore was shipped to the Copper Queen smelter at Douglas, Ariz., to the Calumet and Arizona smelter, Douglas, Ariz., to the Shannon smelter, Clifton, Ariz., and to the Cananea Consolidated Copper smelter, Mexico. Some bullion was shipped to the Omaha (Nebr.) refinery and to Selby, Cal. Zinc ore and concentrates were shipped to smelters and zinc oxide plants in Kansas, Oklahoma, Wisconsin, and eastern points. Within the State, the San Pedro copper matting plant was operated from July on, and the New State Co. operated for a short time the old smelter at Socorro.

MINING INDUSTRY IN NEW MEXICO IN 1912.

In 1912 the output of all the metals in New Mexico increased, the increase in total value over the yield in 1911 being $5,823,112, representing an increase of 215 per cent. Copper production showed the greatest increase, from 4,057,040 pounds in 1911 to 34,030,964 pounds in 1912, an increase in quantity of 29,973,924 pounds, or 739 per cent, and, with the higher average yearly price, an increase in value of $5,107,979, or over 1,000 per cent. The zinc production also increased 33 per cent in quantity, and, at the higher average yearly price, increased in value 61 per cent. The production of silver increased over 13 per cent in quantity, and, at the higher average yearly price, increased almost 32 per cent in value. The yield of lead was almost twice that of the 1911 yield. Gold increased slightly.

The Mogollon district, Socorro County, 80 miles from the nearest railroad at Silver City (in Grant County), is the most important district in New Mexico in the output of gold and silver. The production in 1912 of $524,858 for gold and 1,093,158 ounces of silver shows little change from the yield in 1911, which was larger than that of 1910. The ore is siliceous, oxidized, and sulphide, with very little base metals,[1] carrying (in 1912 in terms of recovered metal) 0.2505 ounce or $5.178 in gold per ton, and 10.78 ounces, or $6.63 in silver. All the ore is milled in the district, by concentration, sliming, and agitation and percolation in cyanide solution, the bulk of the product being cyanide precipitates, with a few cars of high-grade concentrates. There are 5 mills in the district (3 operated almost continuously, 1 operated part of the year, and 1 idle, in 1912), with a possible gross capacity of 500 to 600 wet tons per day, and an actual tonnage treated for 1912 of 290 wet tons per day. The auriferous pyritic quartz veins of White Oaks, Lincoln County, have yielded a large quantity of gold, but there was a small decrease in the yield for 1912. The ore is chiefly amalgamated, cyanidation being used occasionally. The Elizabethtown district, Colfax County, in point of total production one of the leading mining districts in New Mexico both from placers and lode mines, remained the most important placer district in the State; and the continuing of operations of the Aztec mine and amalgamation-concentration-cyanidation mill (begun in 1911), with experiments on the Ajax ore with cyanidation in 1912, maintained the lode production for the year. The primary gold deposits of the Elizabethtown district are of two types, quartz-pyrite veins and contact metamorphic deposits in calcareous sediments, the former having produced much the greater portion of the gold. The ore deposit of the Ajax mine is of the contact metamorphic type. After the Mogollon district, the second gold and silver producing district is the Lordsburg district, Grant County, fissure veins in that district yielding in 1912 increased shipments of siliceous gold and silver bearing copper and dry ores. (The low-grade copper deposits of the Chino Copper Co., at Santa Rita, carry practically no precious metals.) Basic oxidized and sulphide ores of gold and copper of the Jarilla district, near Orogrande, Otero County, again yielded an increased gold output, and placer operations also yielded an appreciable quantity of gold. The reopening in July, 1912, of the mines and smelter

[1] In one or two veins (not worked since 1907) are found important quantities of the copper minerals, bornite and chalcocite.

of the Santa Fe Gold & Copper Mining Co., at San Pedro, Santa Fe County, resulted in a considerable yield of gold and silver in the matte yielded in the smelting of the copper ores of this property, which are of the contact metamorphic type. The tonnage of the base ores of the Las Animas district, near Hillsboro, chiefly sulphides of copper carrying gold and silver, decreased heavily, although the small output of gold from dry placers in this district was nearly twice that of 1911. Lead and iron concentrates from the lead-zinc ores of Magdalena furnished some silver.

Copper has been an important metal in the production from New Mexico, the recorded output from 1845 to 1910 having been 92,323,163 pounds.[1] For 1912 the value of the yield of copper alone was twice that of the value of the total metallic yield of the State for 1911. This large production is principally due to the output of the Chino Copper Co., mining with steam shovels a large acreage of low-grade copper deposits at Santa Rita and milling at Hurley, where an average of approximately 3,000 tons a day was treated during 1912. At the close of the year this mill was completed to five sections of 1,000 tons capacity each, although the plant has demonstrated a capacity of 1,200 tons or more per section. The company reports ore reserves of over 90,000,000 tons of 1.8 per cent copper. The copper output from Lordsburg, Grant County, was 20 per cent greater than in 1911 and nearly twice the output of 1910. The mines and 125-ton matting plant at San Pedro, Santa Fe County, were reopened in July and operated throughout the year. In the Burro Mountain district, Grant County, much development work on the copper-ore deposits has been done for several years, particularly since 1906, little ore being marketed during the period. In 1912 development work was continuous, although on a smaller scale than in former years, but in 1913 active development was commenced again.

The output of lead increased appreciably. The yield from the lead and lead-zinc ores of Magdalena showed only a small increase, the increase for the State being due chiefly to increased shipments from Central district, Grant County,, and to shipments of lead carbonate from Cooks and Victorio districts, Luna County (opened in the mining of zinc carbonates). There was only a small yield of lead from Organ district, Dona Ana County, which has been an important producer of lead from 1854 to 1909.

The zinc output in 1912 came chiefly from Kelly, Socorro County, marketed as sulphide zinc concentrates and crude carbonate zinc ore, with a small decrease in tonnage of concentrates but an increase in tonnage of carbonates, with a resultant small increase of estimated recovered metal; also from Central district, Grant County, from carbonate ores; from Pinos Altos district, Grant County, from zinc sulphide concentrates; and from Cooks, Tres Hermanas, and Victorio districts, Luna County, from zinc carbonate ore.

At Kelly, the new mill of the Ozark Co.—a wet concentration and acid flotation mill—was nearly completed in 1912 and was set in operation in 1913. The Tri-Bullion magnetic and wet mills were operated almost continuously during the year.

[1] Butler, B. S., Mineral Resources for 1910, pt. I, 1911, p. 204.

The following tables show the results of mining operations in New Mexico in 1912:

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1912, by counties.

County.	Tonnage.	Gold.[a]		Silver.[a]	
		Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*	
Colfax	3,025	1,727.03	$35,701	634	$390
Dona Ana	78	.82	17	1,790	1,101
Grant	1,200,691	8,039.74	166,196	356,057	218,975
Lincoln	2,003	1,084.37	22,416	1,005	618
Luna	3,090	275.11	5,687	24,265	14,923
Otero	3,792	630.76	13,039	1,107	681
Rio Arriba		4.84	100		
Santa Fe	15,335	557.18	11,518	14,178	8,719
Sierra	252	200.42	4,143	11,236	6,910
Socorro	124,020	25,427.30	525,629	1,126,429	692,754
Total	1,352,286	37,947.57	784,446	1,536,701	945,071

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Colfax	6,243	$1,030					$37,121
Dona Ana	6,685	1,103	26,129	$1,176			3,397
Grant	32,952,133	5,437,102	2,309,732	103,938	3,135,000	$216,315	6,142,526
Lincoln	9,988	1,648	103,911	4,676			29,358
Luna			827,556	37,240	458,594	31,643	89,493
Otero	146,588	24,187					37,907
Rio Arriba							100
Santa Fe	810,563	133,743	12,511	563	10,565	729	155,272
Sierra	8,988	1,483	21,001	945			13,481
Socorro	89,776	14,813	2,193,178	98,693	9,962,478	687,411	2,019,300
Total	34,030,964	5,615,109	5,494,018	247,231	13,566,637	936,098	8,527,955

[a] Includes placer production.

Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver in bullion produced in New Mexico from 1909 to 1912, inclusive.

Year.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
1909	32,830	6,725.84	169,650	78,782
1910	67,148	14,220.94	412,272	61,379
1911	109,113	21,894.14	771,014	59,622
1912	106,208	20,342.58	842,018	1,142,002
Increase (+) or decrease (−)	−2,905	−1,551.56	+71,004	+1,082,380

Mine production of gold, silver, copper, lead, and zinc from New Mexico concentrates from 1909 to 1912, inclusive.

Year.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	7,554	1,598.31	112,639	2,015,118	436,558	821,766
1910	18,298	4,536.03	255,060	1,050,238	2,701,843	6,882,175
1911	16,243	7,938.70	333,654	1,125,927	1,562,768	5,304,000
1912	81,811	7,190.63	290,081	28,760,908	1,984,435	6,404,768
Increase (+) or decrease (−)	+65,568	−748.07	−43,573	+27,634,981	+421,667	+1,100,768

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore shipped to smelters from 1909 to 1912, inclusive.

Year.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	52,544	2,196.50	115,332	3,378,028	4,593,209	12,264,179
1910	63,338	3,317.99	176,281	3,564,148	1,618,998	11,205,954
1911	63,964	6,162.71	249,710	2,931,113	1,403,454	4,933,176
1912	104,076	9,595.57	404,462	5,270,056	3,509,583	7,161,869
Increase	40,112	3,432.86	154,752	2,338,943	2,106,129	2,228,693

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore and concentrates combined shipped to smelters, from 1909 to 1912, inclusive.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	60,098	3,794.81	227,971	5,393,146	5,029,767	13,085,945
1910	81,636	7,854.02	431,341	4,614,386	4,320,841	18,088,129
1911	80,207	14,101.41	583,364	4,057,040	2,966,222	10,237,176
1912	185,887	16,786.20	694,543	34,030,964	5,494,018	13,566,637
Increase	105,680	2,684.79	111,179	29,973,924	2,527,796	3,329,461

Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver in bullion produced in New Mexico in 1912, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Colfax	2,910	821.51	173	.....
Grant	50	60.76	2,488	1,125,010
Lincoln	1,852	1,035.61	117	.....
Otero	.....	.....	.....	1,200
Santa Fe	.....	.....	.....	752
Sierra	35	18.90	3	.....
Socorro	101,361	18,405.80	839,237	15,040
Total	106,208	20,342.58	842,018	1,142,002

Mine production of gold, silver, copper, lead, and zinc from New Mexico concentrates in 1912, by counties.

County.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	40	178.54	96	553	.....	.....
Grant	69,186	.....	5,787	28,696,954	1,411	861,492
Otero	34	.....	47	18,541	.....	.....
Santa Fe	188	.39	1,040	8,670	12,511	10,561
Socorro	12,363	7,011.70	283,111	36,190	1,970,513	5,532,751
Total	81,811	7,190.63	290,081	28,760,908	1,984,435	6,404,768

Classification of concentrates and contents from New Mexico ore in 1912.

Character.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc (as spelter).	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	370	7,162.75	254,017	737	386	.....	$304,427
Copper	67,675	.....	4,667	28,702,749	.....	.....	4,738,824
Lead and iron	3,539	27.86	31,397	57,422	1,984,049	.....	560,571
Zinc	10,227	.....			.....	6,404,768	

Kinds of concentrates and average recovered metallic content of milling ore and concentrates produced in New Mexico in 1912.

Kinds of concentrates and source of production.	Milling ore.	Concentrate.	Average metallic content per ton.									
			Gold.		Silver.		Copper.		Lead.		Zinc.	
			Crude ore.	Concentrate.	Crude ore.	Concentrate.	Crude ore.	Concentrate.	Crude ore.	Concentrate.	Crude ore.	Concentrate.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry or siliceous: Gold and silver mills	104,261	370	[a] 0.25	19.358	[a] 10.39	686.53	.....	0.10	.....	0.05	.....	.....
Copper: Concentration mills	1,121,575	67,675	.....	.....	.004	.07	1.27	21.21	.....	.....	.....	.....
Lead and iron	20,427	3,539	[b] .001	[b] .007	[b] 1.54	[b] 2.28	[b] .14	[b] .21	4.9	[c] 28.00	.....	.....
Zinc: Concentration mills		10,227	.....	.....					.....	.....	[d] 18.5	[d] 37.0

[a] Includes 0.18 ounce gold and 7.95 ounces silver per ton recovered by cyanidation.
[b] Recovered in lead concentrates and zinc residues.
[c] Iron concentrates cut down average. Lead concentrates average much higher.
[d] Average gross content, without deduction for loss in smelting.

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore shipped to smelters in 1912, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	115	321.36	289	5,690	.....	.....
Dona Ana	78	.82	1,790	6,685	26,129	.....
Grant	75,631	7,855.57	347,743	4,255,179	2,308,321	2,273,508
Lincoln	151	.....	883	9,988	103,911	.....
Luna	3,090	275.11	24,265	.....	827,556	458,594
Otero	2,592	532.37	1,046	128,047	.....	.....
Santa Fe	14,583	493.81	13,134	801,893	.....	.....
Sierra	217	106.73	11,231	8,988	21,001	.....
Socorro	7,619	9.80	4,081	53,586	222,665	4,429,767
Total	104,076	9,595.57	404,462	5,270,056	3,509,583	7,161,869

Tonnage of ore to gold and silver mills, with quantity of gold and silver contained in bullion produced in New Mexico in 1912, by processes.

Quantity.	Process.	Gold in bullion.	Silver in bullion.
Short tons.		*Fine ounces.*	*Fine ounces.*
106,208	Amalgamation	1,781.21	443
	Cyanidation	18,561.37	841,575
106,208		20,342.58	842,018

Consumption of quicksilver and cyanide in New Mexico mills in 1912.

Quicksilver.	Potassium cyanide.	Sodium cyanide.
Pounds.	*Pounds.*	*Pounds.*
[a] 187	[b] 22,935	[b] 124,100

[a] Represents 1 pound of quicksilver for every 9.52 ounces of gold.
[b] Represents 1 pound of cyanide for every 0.126 ounce of gold, and 1 pound cyanide for every 5.72 ounces of silver.

Subdivision of tonnage of ore sold or treated in New Mexico in 1912, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Colfax	3,025						3,025
Dona Ana		1	32		45		78
Grant	9,815	1,178,074	4,168	8,634			1,200,691
Lincoln	1,852	20	8		123		2,003
Luna			2,267	823			3,090
Otero	932	2,860					3,792
Santa Fe		14,583				752	15,335
Sierra	182	40	30				252
Socorro	101,361	105	347	6,937		15,040	124,020
Total, 1912	117,167	1,195,683	6,852	16,394	398	15,792	1,352,286
Total, 1911	135,034	69,305	3,175	8,402	450	16,333	232,699
Increase (+) or decrease (−)	−17,867	+1,126,378	+3,677	+7,992	−52	−541	+1,119,587

Output of ore, and production of metals in New Mexico in 1912, by kinds of ore.

Source of production.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers		818.79	140			
Siliceous (or dry) ore	117,167	29,503.13	1,141,786	395,552	14,860	
Copper ores	1,195,683	7,284.74	290,568	33,528,958	178,937	
Lead ores	6,852	309.60	68,936	8,724	3,107,561	
Zinc ores	16,394		1,167	12,746	33,802	8,023,361
Copper-lead ores	398	3.43	3,874	40,308	176,220	
Lead-zinc ores	15,792	27.88	30,230	44,676	1,982,638	5,543,276
Total	1,352,286	37,947.57	1,536,701	34,030,964	5,494,018	13,566,637

Crude ore by kinds, and average metallic content of each kind in New Mexico in 1912.

Kinds of crude ore.	Tonnage.	Average metallic content per ton.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.[a]	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous	117,167	0.252	9.75	0.17	0.006	.....	$11.76
Copper	1,195,683	.006	.24	1.40	.007	.....	4.91
Lead	6,852	.045	10.06	.06	22.675	.....	27.74
Zinc	16,394	.....	.07	.04	.103	28.2	[b] 34.03
Copper-lead	398	.009	9.78	5.09	22.250	.....	42.80
Lead-zinc	15,792	.002	1.91	.14	6.277	20.6	[b] 31.55
Total	1,352,286	.....	.....	.....	.....	.....	6.29

[a] Average gross content, without deduction for loss in smelting.
[b] Average gross value, loss in zinc smelting deducted.

REDUCTION MILLS IN NEW MEXICO.

List of reduction mills in New Mexico in 1912, by counties.

COLFAX COUNTY.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
				Short tons.
Ajax [a]	Elizabethtown (Willow Creek).	Cyanidation	1 Blake crusher, 10 stamps (850 pounds), 1 tube mill, 1 Paterson hydraulic agitator. Decantation process.	40
Aztec [a]	Baldy (Ute Creek)	Amalgamation, concentration, cyanidation.	1 crusher, 40 stamps (10 operated, 1912), 1 Yeatman classifier, 2 Wilfley tables, 4 percolation tanks. Cyanidation of tailings.	80
Gold & Copper Deep Tunnel M. & M. Co.[b]	Elizabethtown	Amalgamation	5-foot Huntington mill	20
Fletcher [b]	Baldy	do	15 stamps	20

DONA ANA COUNTY.

Bennett-Stephenson.[b]	Organ	Concentration	Crusher, rolls, Faust jigs, 4 tables, 1 vanner.	250
Modoc [b]	do	do	Crusher, rolls, Wilfley tables, vanners.	50
Mormon [b]	do	Amalgamation, concentration.	Huntington mill, tables	35

GRANT COUNTY.

Burro Mountain [b]	Burro Mountain	Concentration	Old mill, torn down in 1912	250
Monarch [b]	Carpenter (Swarts post office).	do	Crusher, rolls, tables	100
Hurley (Chino Copper Co.).[a c]	Central (Hurley post office).	do	2 No. 8 gyratory crushers, 12 rolls, 15 Chilean mills, Richards classifiers, 500 Isbell vanners, 70 double-deck Garfield and 30 Wilfley tables. Wet concentration.	5,000
Utter's (Cleveland).[a]	Pinos Altos	do	1 crusher, McFarlane rolls, Richards classifier, 2 Wilfley tables, jigs, 3 trommels, 1 slimer.	125

[a] Active (producing) 1912.
[b] Idle 1912.
[c] For description see Min. and Sci. Press, Mar. 30, 1912, pp. 464–466.

List of reduction mills in New Mexico in 1912, by counties—Continued.

GRANT COUNTY—Continued.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
				Short tons.
Comanche [a]	Silver City	Concentration	3 Blake crushers, 3 grand roller mills, 12 Wilfley tables, 4 Hartz jigs.	250
Mammoth [a]	Pinos Altos	do	1 crusher, 10 stamps	10
Clear Lake [b]	Steeple Rock	Concentration, cyanidation.	10 stamps, cyanide annex	80
Carlisle [a]	do	Amalgamation, concentration.	3 Fraser & Chalmers crushers, 60 stamps (900 pounds), 24 Fraser & Chalmers vanners.	128
Beck [a]	Steins	Concentration	1 crusher, 1 Elspass roller mill, homemade classifier, 3 Wilfley tables.	30–40
Volcano [a]	do	Amalgamation	10 stamps	30
		LINCOLN COUNTY.		
Parsons [a]	Nogal	Amalgamation	6 5-foot Huntington mills, plate amalgamation.	100
Vera Cruz [a]	do	Amalgamation, cyanidation.	5 Huntington mills, crusher, rolls, plate amalgamation.	200
Wisconsin [a]	Jicarilla	Amalgamation, concentration.	Elspass mill, 2 concentrating tables.	50
Old Abe [b]	Whiteoaks	Amalgamation, cyanidation.	1 Blake crusher, 20 stamps, 6 percolation tanks, 6 filters.	40–50
South Homestake (Wild Cat). [b]	do	Amalgamation	10 stamps, amalgamation plates.	20
		OTERO COUNTY.		
Tularosa [b]	Bent post office	Concentration	1 crusher, 3 roller mills, 1 set regrinding rolls, 3 Callow thickeners, 5 Callow classifiers, 6 Wilfley, 5 Deister, 2 canvas tables, 1 impact screen.	125–150
		RIO ARRIBA COUNTY.		
Tusas Peak (Tampa and Whale) [a]	Tusas (Bromide)	Leaching	Waterbury process, 2 crushers, percolation tanks.	100
Red Jacket [a]	Hopewell	Amalgamation, concentration.	5 stamps, 6-foot Huntington mill, card table.	20
		SAN MIGUEL COUNTY.		
Romero [c d]	Porvenir	Concentration	1 crusher, 2 roller mills, 1 King mill, 2 Wilfley tables.	10
Tecolote [a]	Tecolote	Leaching	Leaching tanks	50
Blake [a]	do	do	Crusher, rolls, tanks	50
		SANTA FE COUNTY.		
Cash Entry (Boston-New Mexico). [a]	Cerrillos	Concentration	1 Blake crusher, 2 roller mills, 1 Richards classifier, 9 card tables, Hartz jigs.	150
Sunset [b]	do	do	1 Fraser & Chalmers crusher, 2 vanners, 3 Wilfley tables, 3 Deister slimers.	100
Keystone [a]	do	do	1 crusher, 2 Cornish roller mills, 5 hand Joplin jigs, homemade slimer.	50
San Lazarus [a]	San Pedro	Amalgamation, concentration.	One 6-foot Huntington mill, 1 Wilfley table.	25

[a] Idle 1912.
[b] Active (producing) 1912.
[c] Building 1912.
[d] Test run 1912.

List of reduction mills in New Mexico in 1912, by counties—Continued.

SIERRA COUNTY.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
				Short tons.
Silver Monument [ab]	Chloride	Concentration	1 Blake crusher, 1 Davis roller mill, 2 Isbell vanners, 1 Standard and 2 Wilfley tables.	30
U. S. Treasury [c]	do	Cyanidation	2 tube mills, 2 Akins classifiers, 5 agitation tanks, filter press, 4 Dorr thickeners.	50
Minnehaha [a]	Fairview	Amalgamation, concentration, cyanidation.	Stamps, amalgamating plates, tube mill, Dorr classifier, concentrating tables, cyanide plant.	50
Keystone [a]	Kingston	Concentration	Crusher, Wilfley tables	30
Ocean Wave [a]	Hermosa	do	Crusher, 20 stamps (750 pounds), 4 Wilfley tables, 2 Wilfley slimers.	50
Bonanza [a]	Las Animas (Hillsboro).	do	1 Dodge crusher, 20 stamps (800 pounds), 3 Wilfley tables.	50
Ready Pay [a]	do	Amalgamation, concentration.	1 jaw crusher, 2 Huntington mills, plates, 2 Wilfley tables. Mill reported to be unsatisfactory.	30
Statehood [a]	do	do	Wilfley tables	100

SOCORRO COUNTY.

Deadwood [d]	Mogollon	Concentration, cyanidation.	2 crushers, 15 stamps (1,050 pounds), Bayliss classifier, Dorr classifier, 3 Wilfley tables, 7 leaching tanks, 3 agitators, 1 Portland filter. Automatic sampler.	65
Enterprise [a]	do	Cyanidation	1 Sturtevant crusher, 2 Sturtevant rolls, 1 Dorr classifier, 6 agitation tanks, 1 Kelly filter press.	75–100
Last Chance (Ernestine). [d]	do	Concentration, cyanidation.	1 Blake crusher, 40 stamps (1,050 pounds), 3 Dorr thickeners, 1 Dorr classifier, 5 "New Standard" concentration tables, 8 percolation, 5 agitation tanks. Moore filter process.	110
Fanny [d]	do	do	1 Kennedy crusher, 30 stamps (1,050 pounds), 9 Wilfley tables, sliming in 2 tube mills. Agitated in 5 Pachuca tanks, filtered in 3 Burt filter presses. 2 Dorr classifiers, 2 Dorr thickeners.	180
Treasure [de]	do	do	30 stamps, Akins classifier, 3 Wilfley tables, settlers, leaching tanks.	80
Mistletoe [a]	Magdalena	Dry concentration.	1 crusher, classifier, Sutton, Steele & Steele dry tables.	50
Ozark [c]	do	Wet concentration.	1 Blake crusher, 1 Allis-Chalmers roller mill, 1 No. 6 Chilean mill, 1 tube mill, 4 Richards, 7 Ovaca classifiers, 6 Deister sand, and 8 slime tables. Acid-flotation process.	100
Tri-Bullion [d]	do	Magnetic separation and wet concentration.	8 Traylor tables, 2 Deister slime tables, 4 Dean magnetic separators.	1,800
Golden Bell [a]	Rosedale	Amalgamation	2 Nissen stamps (1,250 pounds). Mill only partly completed.	20

TAOS COUNTY.

Willard [a]	Red River	Amalgamation, concentration.	2 crushers	2
Hamm [af]	Rio Hondo	Wet concentration	1 Blake crusher, 10 stamps (1,050 pounds), 1 classifier, 3 concentrating tables.	50

[a] Idle 1912.
[b] Mill remodeled 1912.
[c] Building 1912.
[d] Active (producing) 1912.
[e] For description see Eng. and Min. Jour., Sept. 7, 1912, p. 454.
[f] Test run 1912.

Mills in New Mexico in 1912, according to processes used, and classified as active, idle, or building.

Process.	Active.	Idle.	Building.	Total.
Amalgamation	1	5	.....	6
Concentration	[a] 5	[b] 15	[c] 2	22
Cyanidation	1	1	1	3
Amalgamation and cyanidation	1	1	.....	2
Amalgamation and concentration	.....	8	.....	8
Amalgamation, concentration, and cyanidation	1	1	.....	2
Concentration and cyanidation	5	.....	.....	5
Leaching	.....	3	.....	3
Total	14	34	3	51

[a] Includes 1 wet concentration and magnetic separation combined.
[b] Includes 1 dry concentration.
[c] Includes 1 wet concentration and acid flotation combined.

REVIEW BY COUNTIES.

BERNALILLO COUNTY.[1]

No ore was marketed from Bernalillo County in 1912. In this county there are several prospects in the Coyote, Hell Canon, and Soda Springs districts.

COLFAX COUNTY.[2]

Elizabethtown district (including Baldy).—This district remains the principal producing placer district in New Mexico, with a yield of $8,385 in placer gold in 1912, as compared with $9,860 in 1911.

Of the 3 producing lode mines in 1911, only 1, the Aztec, was worked in 1912. The greater part of the ore is treated by amalgamation, cyanidation, and concentration. Several cars of crude ore were shipped to Pueblo, Colo. At the Golden Ajax mine was installed an experimental plant consisting of a Paterson hydraulic agitator and a tube mill, and several tons of tailings were treated.

The following table shows the production of Elizabethtown and Baldy districts (which is the output for Colfax County) from 1904 to 1912, inclusive:

Mine production in Elizabethtown district, Colfax County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	380	$90,639	$3,638	67	.....	.....	$94,316
1905	13	31,994	445	157	.....	.....	31,749
1906	.....	14,492	.....	93	.....	.....	14,554
1907	.....	11,914	.....	83	.....	.....	11,969
1908	.....	11,274	.....	66	.....	.....	11,309
1909	83	16,037	1,705	127	.....	.....	17,808
1910	93	9,588	3,433	261	.....	2,182	13,258
1911	2,306	9,860	31,547	1,254	5,587	.....	42,770
1912	3,025	8,385	27,316	634	6,243	.....	37,121
Increase (+) or decrease (—)	+719	—1,475	—4,231	—620	+656	.....	—5,649

[1] Lindgren, W., The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 162–163.
[2] Idem, pp. 18, 32, 36, 41, 51–54, 57–59, 60, 75, 91–108, 348.

DONA ANA COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Dona Ana County, N. Mex., 1904-1912.

Year.	Tonnage.	Gold.	Silver	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	5,580	.....	24,101	40,000	1,581,488	.....	$87,145
1905	6,566	$6,710	21,776	96,058	327,707	30,000	52,020
1906	16,220	.....	34,051	434,000	1,207,193	.....	175,386
1907	6,084	6	25,612	776,125	675,189	.....	207,920
1908	3,090	.....	9,283	21,150	379,697	.....	23,660
1909	2,816	248	16,975	10,600	772,023	.....	43,650
1910	2	.....	15	.....	705	.....	39
1911	5	.....	111	353	1,561	.....	173
1912	78	17	1,790	6,685	26,129	.....	3,397
Increase	73	17	1,679	6,332	24,568	.....	3,224

Organ Mountains district.[1]—A small lot of lead ore was shipped from the Big Three group and several cars of copper-lead ore were shipped from the Memphis mine. A trial lot of oxidized lead ore was shipped from the Homestake mine. Sulphide ore, carrying gold, silver, copper, and iron pyrites, is reported at a depth of 160 feet in the Homestake mine.

GRANT COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Grant County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	47,032	$8,081	$60,347	74,793	4,428,508	179,142	.....	$695,099
1905	81,160	10,943	35,064	86,629	5,291,222	321,035	257,203	954,026
1906	127,800	2,290	97,519	163,987	6,388,830	710,895	144,656	1,492,069
1907	146,746	3,782	109,260	224,279	8,046,315	1,394,390	73,729	1,948,582
1908	75,254	3,514	42,168	95,477	5,242,767	244,589	251,070	810,403
1909	89,576	3,584	34,242	74,198	5,176,585	215,070	203,278	769,590
1910	70,862	2,641	63,291	156,557	4,404,394	257,953	1,285,500	790,598
1911	93,770	4,043	112,241	221,882	3,918,928	694,247	306,895	772,481
1912	1,200,691	2,551	163,645	356,057	32,952,133	2,309,732	3,135,000	6,142,526
Increase(+) or decrease(−)	+1,106,921	−1,492	+51,404	+134,175	+29,033,205	+1,615,485	+2,828,105	+5,370,045

Apache No. 2 (Anderson) district.[2]—A large tonnage of low-grade oxidized copper ore, rich in calcite, but also carrying some silver, was shipped from the Apache mine, 6 miles from Hachita.

Burro Mountain district.[3]—Several cars of high-grade copper ore were shipped from this district. Continuous development work, but on a small scale, was done on the properties of the Burro Mountain Copper Co. This company in August, 1912, acquired the Chemung property, which has been actively developed since May, 1906. The

[1] Lindgren, W., op. cit., pp. 205–213.

[2] As distinguished from Apache (Chloride) district, Sierra County. See Hill, J. M., Mining districts of Western United States: Bull. U. S. Geol. Survey No. 507, 1912, pp. 231, 240.
Lindgren, W., op. cit., pp. 343–344.
Weed, W. H., The copper mines of the United States in 1905: Bull. U. S. Geol. Survey No. 285, 1906, p. 118.

[3] Lindgren, W., op. cit., pp. 17, 19, 27, 28, 38, 61, 62, 321–324.
Paige, S., Metalliferous ore deposits near the Burro Mountains, Grant County: Bull. U. S. Geol. Survey No. 470, 1911, pp. 131–150.
Weed, W. H., op. cit., p. 118.

old 200-ton mill of the Burro Mountain Co. was dismantled. Active development of the two properties was commenced in 1913. A large tonnage of low-grade copper has been blocked out.

Central district.[1]—The output of the Central district, embracing the towns of Bayard, Fierro,[2] Georgetown,[3] Hanover,[4] and Santa Rita,[5] was 1,136,290 tons, yielding $998 in gold, 29,586 ounces of silver, 29,512,812 pounds of copper, 2,172,676 pounds of lead, and 2,205,824 pounds of zinc, with a total value of $5,138,779, as compared with $325,156 in 1911. This district is the first in New Mexico in point of production, the value of the output representing 60 per cent of the State yield. Besides the Chino Copper Co.'s mines at Santa Rita, there were 15 other producing properties in this district. From Hanover zinc carbonate ore was shipped from the Mountain Home group, Pewabic, Welch, and Empire Zinc Co.'s mines. A considerable tonnage of lead ore was shipped from the Lucky Bill mine, near Bayard. Copper ore was shipped from the Dewey and Schley, the Gilchrest-Dawson, the dump of the Ivanhoe group, and the San Jose group mines.

The Chino Copper Co. is mining a low-grade copper deposit at Santa Rita by steam shovels. This ore is concentrated at Hurley, where a 5,000-ton plant has been erected in five sections, two sections being in operation at the beginning of the year 1912, and the other three being successively placed in operation during the year, the last being completed in December. Concentrates are shipped to El Paso. Some crude copper ore was also shipped in 1912.

The third annual report of the Chino Copper Co., dated April 15, 1913, covering the year ended December 31, 1912, says:

> Throughout the year a limited amount of development drilling was continued. * * * The last annual report showed 54,970,646 tons of ore (reserves), containing an average of 2.24 per cent copper. * * * The ore reserves, which may now be considered as fully developed, amount to over 90,000,000 tons, containing an average slightly above 1.8 per cent copper. * * * It is estimated that * * * about 80,000,000 tons of average grade, or nearly 90 per cent of the total reserves, will be available for steam-shovel mining.
>
> * * * No more than four sections of the mill were operated continuously for any period during the year. * * * The total tonnage treated for the year was 1,120,375 tons. * * * The average copper content of the ore treated during the year was 2.077 per cent and the average recovery in concentrates was 61.63 per cent. * * * During the month of July, when clear ores were available * * * the recovery was * * * 75 per cent. The total production for the year of copper contained in concentrates was 28,684,208 pounds, the average grade of concentrates produced being 21.2 per cent and the ratio of concentration 16.56 tons into one. This grade of concentrates is lower than it will be normally, because of the excessive amount of carbonates in the ore treated. * * * During the latter part of the year 2,291 tons of ore produced from the Hearst section and containing a little over 12 per cent copper (553,758 pounds) were shipped direct to the smelter at El Paso * * * making the total gross production for the year * * * 29,237,966 pounds.
>
> The average cost of net copper produced from concentrates, after deductions for smelter allowances, was 7.69 cents per pound, and the cost of production from crude-ore shipments was 6.98 cents per pound.[6]

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[1] Lindgren, W., op. cit., pp. 57, 61, 317–318.
Weed, W. H., op. cit., p. 118.

[2] Lindgren, W., op. cit., pp. 47, 55, 296, 306, 312–313.
Paige, S., The Hanover iron-ore deposits, New Mexico: Bull. U. S. Geol. Survey No. 380, 1909, pp. 199–214.

[3] Lindgren, W., op. cit., pp. 18, 30, 38, 62, 63–65, 306–307, 318–319.

[4] Birkinbine, J., Iron ores of the United States: Eighteenth Annual Rept. U. S. Geol. Survey, pt. 5, 1897, pp. 48–50.
Lindgren, W., op. cit., pp. 3, 5, 18, 38, 41–43, 51–53, 55, 57–58, 305, 317.
Paige, S., op. cit., pp. 119–214.
Weed, W. H., op. cit., p. 118.

[5] For description of previous operations, see Henderson, Charles W., Mineral Resources U. S. for 1910, pt. 1, U. S. Geol. Survey, 1911, p. 546, and Mineral Resources U. S. for 1911, pt. 1, 1912, pp. 715–716.

The following table shows the production of Central district from 1904 to 1912:

Production of gold, silver, copper, lead, and zinc in the Central district, Grant County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	21,048	$5,582	282	3,264,208	11,977	.....	$430,607
1905	17,115	.....	.....	2,704,233	.....	.....	421,860
1906	39,155	4	2,524	3,075,001	235,070	99,656	614,648
1907	57,079	5,659	36,813	4,994,575	855,358	73,729	1,078,555
1908	41,852	777	296	3,994,502	29,122	251,070	541,231
1909	41,456	816	1,380	3,348,808	23,256	203,278	448,856
1910	37,008	.....	404	2,679,630	155	1,285,500	409,955
1911	45,584	104	8,673	1,413,189	605,978	290,122	325,156
1912	1,136,290	998	29,586	29,512,812	2,172,676	2,205,824	5,138,779
Increase	1,090,706	894	20,913	28,099,623	1,566,698	1,915,702	4,813,623

Chloride Flat district[1] (*near Silver City*).—Lead-silver ore was shipped from the Grand Central mine, and dry oxidized ore, carrying lead and silver, from the Tight Squeeze mine.

Eureka district (*Hachita,*[2] *including Sylvanite*).[3]—Copper ore was shipped from the American mine, in the Eureka district. From Sylvanite several tons of dry ore were shipped from the Hardscrabble mine.

Fremont district.—Several cars of copper ore were shipped from the Nutshell mine, near the boundary lines of Luna and Grant counties and Mexico.

Lordsburg district (*including Pyramid and Virginia, or Shakespeare districts*).[4]

The following table shows the production of Lordsburg district from 1904 to 1912, inclusive:

Production of gold, silver, copper, and lead in the Lordsburg district, Grant County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	250	$1,184	2,580	18,200	12,000	$5,582
1905	366	10	7,584	48,000	.....	12,079
1906	1,743	5,168	27,261	212,601	.....	64,465
1907	5,645	8,761	31,303	463,335	10,522	122,646
1908	7,532	10,617	9,889	259,079	11,363	50,534
1909	10,690	25,983	50,154	589,969	8,862	129,140
1910	29,220	59,798	130,324	1,627,591	19,662	337,742
1911	46,139	106,648	182,448	2,455,336	2,157	510,359
1912	55,340	144,859	275,251	3,155,585	4,562	835,015
Increase	9,201	38,211	92,803	700,249	2,405	324,656

As noted in the table, the tonnage shipped from this district has steadily increased since 1904, reaching a gross value of $835,015 in 1912, an increase over that of 1911 of $324,656. With the exception

[1] Lindgren, W., op. cit., pp. 18, 26, 38, 63–65, 301–305.
[2] Idem, pp. 338–343.
[3] Hill, J. M., Bull. U. S. Geol. Survey No. 507, 1912, pp. 335–338.
[4] Graton, L. C., op. cit., pp. 332–335.
Weed, W. H., op. cit., p. 118.

of one small lot of lead ore, all the ore from this district was siliceous, carrying chiefly copper, but also appreciable quantities of gold and silver. The ore is shipped crude to smelters. The average assay per ton for the district in 1912 was gold 0.1266 ounce, silver 4.974 ounces, and copper 2.85 per cent. The principal producing mines in 1912 were the Atwood, Battleship, Bonney, Dundee, Eighty-five, Miser's Chest, Nevada, and Southern.

Pinos Altos district.[1]—The following table shows the production of Pinos Altos district from 1904 to 1912, inclusive:

Production of gold, silver, copper, lead, and zinc in the Pinos Altos district, Grant County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	4,719	$7,750	$49,660	37,229	104,069	2,653	.....	$92,587
1905	6,348	10,943	31,442	39,585	103,469	.....	160,779	82,442
1906	14,074	2,290	89,674	83,566	328,788	.....	.....	211,409
1907	14,841	3,782	78,723	65,862	322,195	.....	.....	190,413
1908	1,451	1,479	8,548	8,941	34,514	3,953	.....	21,528
1909	38	3,584	2,083	1,377	6,200	418	.....	7,207
1910	20	2,494	1,372	223	269	2,226	.....	4,119
1911	355	4,043	1,406	5,616	3,232	4,063	16,773	9,968
1912	6,169	2,551	7,973	15,864	96,507	50,289	929,176	102,581
Increase (+) or decrease (−)	+5,814	−1,492	+6,567	+10,248	+93,275	+46,226	+912,403	+92,613

Placer mines in this district in 1912 yielded $2,551 in gold, and deep mines yielded 6,169 tons having a gross value of $100,006 for all five metals, the total value for the district being $102,581, as compared with $9,968 in 1911. The principal producing mines were the Cleveland group, yielding chiefly zinc as concentrates, and the Hearst mines of the Savanna Copper Co., yielding all five metals in shipments to smelters. A 125-ton concentration mill was completed at the Cleveland mine in August, 1912, and operated during the rest of the year. Other producing mines were the Arizona, Dimmick, Hardscrabble, and Langston.

Red Hill district.—No ore was shipped from this district, which lies in the southwest corner of New Mexico.

San Simon (Granite Gap)[2] *district (Steins).*—There was no work in this district in 1912.

Steeple Rock[3] *district.*—Cyanide precipitates and a small tonnage of ore were shipped by the American Exploration & Mining Co. from the company's Hinckley mine and cyanide plant. Several cars of gold-silver ore were shipped from the New Strike mine.

Steins Pass (or Kimball)[4] *district.*—Gold-silver ore was shipped from the Nellie Gray mine.

White Signal (or Cow Springs) district (Whitewater).—Several small lots of ore were shipped from this district.

[1] Lindgren, W., op. cit., pp. 18, 35, 38, 43, 57–58, 59, 61, 62, 64, 75, 297–301.
Paige, S., The ore deposits near Pinos Altos, N. Mex.: Bull. U. S. Geol. Survey No. 470, 1911, p. 109–125.
[2] Lindgren, W., op. cit., pp. 51, 53, 62, 63–64, 329–331, 340.
[3] Idem, pp. 68, 69–71, 327–328.
[4] Idem, pp. 68, 69–70, 328–329.

LINCOLN COUNTY.

Mine production of gold, silver, copper, and lead in Lincoln County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	820	$20,100	$8,496	2,576	.....	2,261	$30,183
1905	3,060	2,260	5,215	757	14,404	7,511	10,532
1906	6,380	.....	16,463	1,946	.....	.....	17,767
1907	5,767	.....	41,417	721	.....	.....	41,893
1908	4,399	816	28,896	5,472	1,195	.....	32,770
1909	3,633	472	23,391	388	700	7,977	24,499
1910	10,727	1,400	53,876	559	189	5,614	55,849
1911	1,578	1,629	30,305	184	555	6,620	32,399
1912	2,003	1,008	21,408	1,005	9,988	103,911	29,358
Increase (+) or decrease (−)	+425	−621	−8,897	+821	+9,433	+97,291	−3,041

The value of the mine production in 1912 in Lincoln County from both placer and deep mines was $29,358, as compared with $32,399 in 1911. Both placer and deep mine output decreased.

Gallinas[1] *district.*—Several cars of copper-lead ore, carrying also silver, were shipped from this district.

Jicarilla[2] *district.*—The placer output of the county comes from this district. The yield of placer gold was $1,008 in 1912, as against $1,629 in 1911. A car of copper ore was shipped from the Honey Bee mine.

Nogal[3] *(Bonita, Parsons) district.*—Assessment work only was done in this district in 1912.

White Oaks[4] *district.*—The output from White Oaks district, chiefly gold, decreased slightly. The Wild Cat Leasing Co. operated the Homestake mines and amalgamation mill about half the year. A small tonnage of ore from the Old Abe dump was milled at the Old Abe amalgamation and cyanide mill, and some ore from the Silver Cliff mine was milled.

LUNA COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Luna County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	1,576	$1,695	8,549	16,000	671,772	.....	$37,605
1905	1,346	.....	5,199	.....	463,956	225,000	38,221
1906	1,994	413	11,265	.....	831,193	103,836	61,673
1907	2,048	13,741	8,633	.....	1,022,773	.....	73,646
1908	288	3	1,077	5,934	127,535	.....	6,713
1909	1,163	3,208	6,916	1,115	682,906	.....	36,314
1910	525	26	2,484	47	298,112	.....	14,490
1911	229	104	1,278	1,814	98,888	.....	5,458
1912	3,090	5,687	24,265	.....	827,556	458,594	89,493
Increase (+) or decrease (−)	+2,861	+5,583	+22,987	−1,814	+728,668	+458,594	+84,035

[1] Lindgren, W., op. cit., p. 176.
[2] Idem, pp. 39, 51–53, 57–58, 59, 60, 75, 176, 183–184.
[3] Idem, pp. 39, 57–58, 75, 175–179.
[4] Idem, pp. 19, 39, 57–58, 60, 66, 175–176, 179–182.

Luna County in 1912 produced 3,090 tons of lead and zinc carbonate ore, containing $5,687 in gold, 24,265 ounces of silver valued at $14,923, 827,556 pounds of lead valued at $37,240, and 458,594 pounds of zinc valued at $31,643, with a total value of $89,493, as compared with $5,458 in 1911.

Cooks Peak[1] *district.*—A total of 927 tons of lead and zinc ore was shipped from 9 mines in this district in 1912, with a total value of output of $36,897. Lessees on the Summit group shipped a large tonnage of zinc carbonate ore, and zinc carbonate was also shipped from the Desdemona and Contention mines. Lead ore was shipped from the Clara K., Faywood, Old Commodore, Silver Cave, and West Side mines.

Tres Hermanas[2] *district.*—A car of zinc carbonate ore was shipped from the Colebra mine.

Victorio[3] *(Gage) district.*—Lead carbonate ore, carrying silver and some gold, and assaying 56 per cent of silica, was shipped from the Rambler mine. Oxidization extends downward 200 feet in this mine. Lead and zinc carbonate ores were shipped from the Helen and Jessie mines, and lead carbonate from the Chance group mines.

OTERO COUNTY.

Mine production of gold, silver, copper, and lead in Otero County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	170	$1,050	$1,569	164	14,400	.....	$4,586
1905	117	1,036	41	93	53,602	.....	9,495
1906	268	195	228	533	133,166	.....	26,481
1907	12,203	100	14,711	2,135	679,480	.....	152,116
1908	22,418	1,475	34,215	4,351	723,907	.....	133,552
1909	143	100	157	29	6,354	.....	1,098
1910	2,545	6,022	2,559	2,046	49,874	6,046	16,286
1911	1,096	.....	6,718	715	22,730	739	9,971
1912	3,792	2,034	11,005	1,107	146,588	.....	37,907
Increase (+) or decrease (−)	+2,696	+2,034	+4,287	+392	+123,858	−739	+27,936

The value of the mine production in 1912 in Otero County, from both placer and deep mines, was $37,907, of which $13,039 was for gold, $681 for silver, and $24,187 for copper.

Jarilla[4] *(Orogrande, Silver Hill, Brice) district.*—A large tonnage of oxidized copper ore, carrying also small quantities of gold and silver, were shipped from the Lucky, Nannie Baird, and Maggie mines. Oxidized ore is found in these mines in the deepest levels—200–230 feet. Sulphide ore and a small quantity of oxide copper ore, carrying a small quantity of gold, was shipped from the By Chance mine. Sulphide ores are opened at 70 feet in this mine. Mixed sulphide and oxide copper ores were shipped from the Garnet and the Fisk mines. The Garnet mine is equipped with a 485-foot shaft.

[1] Lindgren, W., op. cit., pp. 37, 39, 62, 63–64, 287–289.
[2] Idem, pp. 38, 41, 51, 55, 57–58, 287, 292–295.
Lindgren, W., The Tres Hermanas mining district, New Mexico: Bull. U. S. Geol. Survey No. 380, 1909, pp. 123–128.
[3] Lindgren, W., Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 18, 43, 62, 63, 64, 287, 290–292.
[4] Idem, pp. 19, 35, 56, 60, 75, 184–187. Weed, W. H., op. cit., p. 118.

It is reported that there is an oxidized zone from the 350-foot to 450-foot level, with a decrease in value in this zone. Surface operations on the Mary H. placer yielded considerable placer gold, part of which was sold for use in fine arts.

Tularosa[1] *district.*—The Tularosa Copper Co. completed the rebuilding and enlarging of its 150 ton concentration mill and operated it during November and December, 1912, shipping copper concentrates carrying some silver.

RIO ARRIBA COUNTY.

Bromide[2] *district* (*Tusas*).—Development work was done on the Pay Roll mine, the ore of which is chiefly chalcopyrite. The prospecting of this property and the Whale mine is under consideration.

Hopewell[3] (*Headstone*) *district.*—A small yield of placer gold was made from the King William placers.

SANDOVAL COUNTY.

Cochiti[4] (*Bland*) *district.*—Only assessment work was done in this district in 1912.

Cuba[5] (*Nacimiento Mountains*) *district.*—No work was done in this district.

Placitas[6] *district.*—Assessment work was done in this district.

SAN MIGUEL COUNTY.

Tecolote[7] *district.*—The Romero Mining Co. made a trial run of its new 5-ton concentration mill. The ore is reported to contain copper and molybdenum.

SANTA FE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Santa Fe County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	170	$4,135	$1,292	.....	2,308	.....	.....	$5,727
1905	180	4,002	2,241	42	.....	.....	.....	2,266
1906	128	6,737	7,143	53	.....	.....	.....	13,916
1907	21,338	1,231	16,748	17,635	1,231,260	.....	.....	275,870
1908	7	1,789	242	6	.....	.....	.....	2,034
1909	2,831	1,817	871	2,295	1,093	213,558	4,426	13,445
1910	4,739	4,262	3,877	3,359	5,150	262,023	74,759	26,173
1911	120	2,359	1,325	2,632	16,644	11,178	.....	7,663
1912	15,335	1,302	10,216	14,178	810,563	12,511	10,565	155,272
Increase (+) or decrease (−)	+15,215	−1,057	+8,891	+11,546	+793,919	+1,333	+10,565	+147,609

[1] Lindgren, W., op. cit., pp. 77, 78, 184, 187–190.
[2] Idem, pp. 49, 50, 51, 124, 126, 130–133.
[3] Idem, pp. 27, 28, 49, 50, 51, 75, 124–130.
[4] Idem, pp. 68, 69, 70, 71, 141, 150–158.
[5] Idem, pp. 77, 78, 143–147. Weed, W. H., op. cit., p. 118.
[6] Idem, p. 141.
[7] Idem, pp. 77, 109, 116–123.

The value of the mine production in 1912 in Santa Fe County, from both placer and deep mines, was $155,272 for all five metals, copper, however, being the most important.

Cerrillos[1] *district.*—A small quantity of placer gold was handled by local merchants in the Los Cerrillos district, and a small yield was made from the Ortiz Grant placer. The 100-ton concentration mill housed in one of the buildings of the old Consolidated smelter was operated for a time on ore from the Tom Payne mine, lead and zinc concentrates being shipped. The 100-ton lead and 30-ton copper furnace, with one 20-foot by 75-foot reverberatory furnace of the old smelter, is out of repair and is not used. The Cash Entry mine and mill were idle. Two cars of copper ore were shipped from the Manhattan group to Denver for testing.

New Placers[2] *and San Pedro*[3] *districts.*—The output of placer bullion of the New Placers district, as handled by local merchants, was less than in 1911. The 125-ton matting smelter of the Santa Fe Gold & Copper Mining Co. was blown in and operated from July 1 throughout the year, matte being shipped for refining to El Paso.

SIERRA COUNTY.

Mine production of gold, silver, copper, and lead in Sierra County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.		Silver.	Copper	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces*	*Pounds.*	*Pounds.*	
1904	1,295	$22,979	$51,617	17,055	16,700	.....	$86,632
1905	3,516	47,878	51,164	8,760	46,664	.....	11,613
1906	3,246	1,509	16,539	8,102	5,995	.....	24,633
1907	700	595	7,629	2,250	5,425	9,548	11,300
1908	680	1,979	16,039	8,589	12,874	6,075	24,524
1909	4,294	.....	10,450	25, 98	25,838	49,023	29,280
1910	8,306	584	11,113	15,778	2,448	11,274	21,024
1911	5,036	823	26,962	16,487	5,374	28,088	38,459
1912	252	1,546	2,597	11,236	8,988	21,001	13,481
Increase (+) or decrease (−)..	−4,784	+723	−24,365	−5,251	+3,614	−7,087	−24,978

Deep mines in Sierra County in 1912 yielded 252 tons, carrying $2,597 in gold, 11,234 fine ounces of silver, 8,988 pounds of copper, and 21,001 pounds of lead, with a total value of $11,934. The placer output was $1,546 in gold and 2 ounces of silver, with a total value of $1,547. The value for both deep and placer mines was $13,481, as compared with $38,459 in 1911.

Caballos Mountains[4] *district.*—A small lot of copper ore from the Fidelity group, and of lead ore from the Vanadium Mines Co.'s property, were shipped.

Chloride[5] *(Apache, Cuchillo Negro) district.*—A shipment of copper ore was made from the Silver Monument mine. A 50-ton cyanide mill was completed on the United States Treasury property.

[1] Clark, F. W., and Diller, J. S., Turquoise from New Mexico: Bull. U. S. Geol. Survey No. 42, 1887, p. 39. Lindgren, W., op. cit., pp. 35, 36, 39, 57, 58, 60, 163–167.
[2] Lindgren W., op. cit., pp. 17, 75, 76, 163, 164, 170–175.
[3] Idem, 51–53, 55, 57–58, 60, 62, 64, 171–174.
[4] Hess, F. L., Vanadium in the Sierra de los Caballos, New Mexico: Bull. U. S. Geol. Survey No. 530, 1912, pp. 157–160.
Lindgren, W., op. cit., pp. 27, 28, 29, 30, 74, 218, 229, 238, 283–285.
[5] Lindgren, W., op. cit., pp. 18, 55, 68–71, 218, 260–266.

Hermosa[1] *district.*—A shipment of lead ore was made from the Ocean Wave mine.

Hillsboro [2] (*Las Animas*) *district.*—Copper ore was shipped from the Wicks Gulch mine, and a small quantity of bullion was marketed from the Statehood amalgamation mill. A considerably increased quantity of placer gold was recovered from the Luxenburg placer by the use of the Quenner "dry washer" machines. There was also a small output from placers operated by Mexicans.

Kingston [3] (*Black Range*) *district.*—A small shipment of high-grade silver ore was shipped from the Templar mine.

Tierra Blanca [4] (*Bromide No. 1*) *district.*—Low-grade silver ore was shipped from the Lake Valley mines.

SOCORRO COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Socorro County, N. Mex., 1911–1912.

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*	
1911	25,844.49	$534,253	1,109,945	$588,271
1912	25,427.30	525,629	1,126,439	692,754
Increase (+) or decrease (−)	−417.19	−8,624	+16,484	+104,483

Year.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
1911	79,321	$9,915	2,124,901	$95,621	9,930,281	$566,026	$1,794,086
1912	89,776	14,813	2,193,178	98,693	9,962,478	687,411	2,019,300
Increase (+) or decrease (−)	+10,455	+4,898	+68,277	+3,072	+32,197	+121,385	+225,214

The output of Socorro County in 1912 showed very little change from that of 1911; the tonnage of ore sold or treated was practically the same for both years; gold production showed a small decrease, and silver, copper, lead, and zinc all showed a small increase, the increased market price for silver and zinc being the chief cause for an increase of $225,214 in total value of the county yield.

Cooney [5] (*Mogollon*) *district.*—The production of Mogollon district in 1912 was 101,361 tons of ore, yielding $524,858 in gold, 1,093,158 fine ounces of silver, and a nominal quantity of copper and lead, with a total value of $1,197,197, an increase of $99,991. The value of the gold output showed a decrease of $6,500, but the value of the silver production, at the increased average commercial

[1] Lindgren, W., op. cit., pp. 18, 55, 62–67, 77, 218, 232, 233, 267–268.
[2] Idem, pp. 18, 30, 31, 37, 39, 43, 62, 64, 65, 68, 69, 70, 75, 214, 218, 227–228, 238, 239, 272–276, 277.
Weed, W. H., op. cit., p. 118.
[3] Harder, E. C., Manganese deposits of the United States: Bull. U. S. Geol. Survey 380, 1909, p. 274.
Lindgren, W., op. cit., pp. 18, 31, 34, 37, 62, 65, 218, 224, 225, 226, 228, 232, 245, 268–270.
[4] Lindgren, W., op. cit., pp. 37, 64, 66, 218, 268–271.
[5] Idem, pp. 18, 42, 43, 44, 47, 68, 69–71, 191–204.

price for 1912, showed an increase of $106,762. The gold output of this district represented 67 per cent of the State yield of this metal, and the silver yield, 71 per cent of the total silver output. The small quantity of copper and lead produced was contained in concentrates.

There were 11 producing mines in this district, as against 6 in 1911, but the tonnage decreased slightly—from 102,219 tons to 101,361 tons. The average assay per ton in terms of recovered metal was 0.2505 ounce, or $5.178, in gold, and 10.78 ounces of silver. A slightly increased tonnage was treated at the Ernestine Co.'s mill, from the Last Chance and the Top mines. The Socorro Mines Co.'s mill was used to treat both ore from the company's Fanny mine and also custom ore from the Johnson, Consolidated, McKinley, Deep Down, and Little Charley mines; the total tonnage treated was about the same as in 1911. The Deadwood mill was used both as a custom mill and for company work. The Treasure mill was operated until August. The mine reports show that the ore in this district is mixed oxide and sulphide, the ore in the deepest working, the Ernestine, being oxidized 1,200 feet below the apex of the vein.

Production of Cooney or Mogollon district, Socorro County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	11,276	$61,880	79,014	422,308	.....	$162,484
1905	15,534	97,158	240,943	295,175	.....	288,735
1906	16,076	127,907	268,567	.....	.....	307,847
1907	20,698	105,413	418,338	150,000	.....	411,516
1908	19,546	116,418	278,939	.....	.....	264,256
1909	23,945	111,464	249,413	46	49	241,167
1910	50,514	304,210	595,669	.....	.....	625,871
1911	102,219	531,358	1,067,038	1,873	1,862	1,097,206
1912	101,361	524,858	1,093,158	184	386	1,197,197
Increase (+) or decrease (−)	−858	−6,500	+26,120	−1,689	−1,476	+99,991

Magdalena[1] *(Kelly) district.*—The output of zinc, the chief metal produced in this district, was 9,962,478 pounds, a small increase for the year.

The Tri-Bullion Smelting & Development Co. was the chief producer, shipping a large tonnage of lead, zinc, and iron concentrates from its magnetic separation and wet concentration mill, a decreased tonnage of zinc carbonate direct from mine to smelters, and several cars of lead carbonate, copper sulphide, and copper-lead sulphide ores. A large tonnage of zinc carbonate and some lead carbonate were shipped from the Juanita mine. Zinc and lead carbonate were shipped by the Ozark Mining & Smelting Co. This company was engaged in building a 100-ton wet concentration mill (using also an acid flotation process). Several shipments of zinc and lead carbonate ores were made from the Germany mine.

[1] Dutton, C. E., Mount Taylor and the Zuni Plateau: Sixth Ann. Rept. U. S. Geol. Survey, 1885, p. 194.
Lindgren, W., op. cit., pp. 18, 19, 47, 51–53, 55, 214, 218, 220, 241–258.
Weed, W. H., op. cit., p. 118.

Production of Magdalena district, Socorro County, N. Mex., 1904–1912.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	27,998	$154	5,024	3,200	688,209	17,991,780	$932,658
1905	30,411	.....	4,800	320,000	390,000	14,630,051	934,322
1906	35,478	.....	2,515	64,560	238,088	17,044,163	1,067,410
1907	3,630	13	4,406	24,045	707,981	676,356	85,158
1908	6,319	72	460	2,605	16,073	3,325,446	157,631
1909	30,724	435	17,925	170,792	3,085,279	12,878,241	860,051
1910	42,232	468	65,880	152,181	3,451,228	16,727,870	1,110,529
1911	25,840	352	42,773	77,448	2,123,039	9,930,281	694,266
1912	22,590	746	32,792	69,532	2,192,792	9,962,478	818,473
Increase (+) or decrease (−)	−3,250	+394	−9,981	−7,916	+69,753	+32,197	+124,207

San Andreas Mountains[1] (*Hembrillo district*).—The St. Lawrence Copper Co. located its property in 1912 and shipped several cars of copper oxidized ore. At a depth of 72 feet, the company reports a change from oxide to sulphide ore. The oxide ores are said to contain platinum.

TAOS COUNTY.

Red River[2] *district.*—Some development work was done on the Willard and Golden Treasure mines.

Rio Hondo[3] *district.*—A trial run of the Hamm mill was made during July.

[1] Lindgren, W., op. cit., pp. 35, 74, 205, 234.
[2] Idem, pp. 35, 36, 42, 43, 68, 69, 70, 71, 82, 84–88.
[3] Idem, pp. 75, 83, 84.

OREGON.

By Charles G. Yale.

PRODUCTION.

Number of mines producing in Oregon, quantity of ore sold or treated, 1905–1912, and total gold, silver, and associated metals.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	233	150,268	$1,405,235	90,636	846,815	1,610	$1,592,156
1906	279	138,274	1,366,900	79,346	415,803	.....	1,500,212
1907	206	110,698	1,129,261	86,718	554,104	.....	1,297,316
1908	239	50,684	865,076	43,602	291,377	2,138	926,737
1909	162	59,281	781,964	27,827	235,000	400	827,001
1910	180	82,132	679,488	35,978	13,861	.....	700,676
1911	176	98,558	633,407	45,221	93,136	.....	669,016
1912	210	90,945	770,041	57,081	260,429	39,317	849,886
Increase (+) or decrease (−) in 1912	+34	−7,613	+136,634	+11,860	+167,293	+39,317	+180,870

In connection with this tabular statement of the metals produced in Oregon, it is to be noted that while the number of mines in operation increased by 34 in 1912, as compared with 1911, the tonnage of ore treated was less in 1912 by 7,613 tons, but that there was an increase in quantity and value in all the metals, the total increase in value being $180,870. The annual total value of the output of metals in the State has been gradually but surely decreasing since 1905, until the year 1912, when a substantial gain over the low record of 1911 was made. The table shows the increase in value of gold. The silver value in 1911 was $23,967; in 1912 it was $35,105, an increase of $11,138. The value of the copper in 1911 was $11,642; in 1912 it was $42,971, an increase of $31,329. No lead production was shown in 1911, but in 1912 the value of the 39,317 pounds produced was $1,769. The showing for the year is highly encouraging. The advance is due mainly to the increase in average value per ton in gold and silver from the siliceous ore from $5.03 in 1911 to $6.84 in 1912, to some increase in copper value, and to the yield of placer gold.

The gold values and silver quantities of the table bear no relation to the figures of tonnage (although the other substances do), for the reason that deep mine and placer mine gold and silver are combined. The gold yield for 1912 was $770,041, of which $580,945 was derived from deep mines and $189,096 from placers of various kinds. Of the total of 57,081 fine ounces of silver for that year, 55,140 fine ounces were from deep mines and 1,941 ounces from the placers. In giving the number of producing mines, both placer and deep mines are included.

The production of the total value of $849,886 in Oregon in 1912 was derived from 210 producing mines, of which 156 were placers of

various kinds and 54 were deep mines. The number of placers increased by 20 in 1912 and the number of deep mines by 14, resulting in an increase of 34 producing mines in all. The total quantity of ore mined and treated in 1912 was 90,945 tons, a decrease of 7,613 tons. The quantity of siliceous ore sold or treated was 86,353 short tons in 1912 (including 28,450 tons of old tailings), a decrease of 8,000 tons, as compared with 1911. The copper ores in 1912 amounted to 4,569 tons, as compared with 4,205 in 1911, an increase of 364 tons. There were 23 tons of lead ore mined and treated in 1912, but none in 1911. The average value of the siliceous ore in 1912 was $6.84 per ton in gold and silver, as compared with $5.03 in 1911, $6.42 in 1910, $9.87 in 1909, and $12.49 in 1908. After a gradual falling off in average values for several years, an increase of $1.81 per ton on 86,353 tons was shown in 1912, which in itself amounts to about $156,000. The copper ore sold or treated in 1912 yielded an average of $4.21 per ton in gold and silver, as compared with $3.32 per ton in 1911, and $4.85 in 1910.

There were treated at gold and silver mills in 1912 in Oregon 47,603 tons of ore, yielding $353,020 in gold and 9,950 ounces of silver, valued at $6,119. In milling the ore, $222,604 in gold and 2,806 ounces of silver were recovered by amalgamation, the average value being $4.68 in gold and 0.036 cent in silver. From these 47,603 tons of milling ore were recovered 1,072 tons of concentrates, with a gold value of $130,416 and 7,144 ounces of silver, valued at $4,392, a total of $134,808, an average value of $121.65 per ton in gold and $4.10 in silver. The average total extraction per ton of crude ore in gold and silver mills, both by amalgamation and in the concentrates, was valued at $7.41 in gold and 13 cents in silver. In addition to this there were 10,130 tons of ore sent to concentrating mills, carrying $72,744 in gold and $18,630 in silver, a total of $91,374. Including all concentrates produced at both gold and silver and concentrating mills, there were 2,818 tons of concentrates, carrying $203,160 in gold and 37,434 ounces of silver, which is an average per ton of $72.09 in gold and $8.17 in silver, a total of $80.26 per ton in gold and silver. The average recovery per ton of crude ore from bullion and concentrates was $7.37 in gold, and 43 cents in silver, a total of $7.80. Crude siliceous ore shipped to smelters amounted to 885 tons, containing $90,126 in gold, and 3,685 ounces of silver, an average value per ton of $101.84 in gold and $2.56 in silver. In addition there were 4,569 tons of copper ore treated, which yielded $12,742 in gold, 10,555 ounces of silver, valued at $6,491, and 260,429 pounds of copper, valued at $42,971. The copper ores yielded $2.79 in gold, 2.3 ounces of silver, and 56.9 pounds of copper per ton. There were 28,450 tons of old tailings treated, yielding $52,035 in gold, and 319 ounces of silver, an average value per ton of $1.83 in gold and 1 cent in silver.

GOLD.

The total output of gold in Oregon in 1912 was 37,250.73 fine ounces, valued at $770,041, an increase of 6,609.67 fine ounces in quantity and of $136,634 in value, as compared with the output of 1911. The largest yield in gold from one county, valued at $484,041, came, as usual, from Baker County, with an increase of $94,255 over the gold yield of this county in 1911. The next county in rank of

gold production was Josephine, followed by Jackson, Lane, Malheur, Grant, Douglas, Curry, Wheeler, Crook, and Coos in the order named. The largest gold production from deep mines was from Baker County, and of placer gold from Josephine County. There were 54 producing deep mines (including 1 silver, 5 copper, and 1 lead), which is 15 more than in 1911. Productive placers numbered 156 in 1912, as compared with 136 in 1911. The placers yielded $189,096 in gold in 1912, as compared with $168,274 in 1911, an increase of $20,822. The hydraulic mines yielded $151,130 in gold, or $38,131 more than in 1911; the drift mines $12,761, or $4,773 less; and the surface mines $25,205, or $2,039 more than in 1911. The output of dredges in 1911 was $14,575, but no returns were received from that source in 1912. There were 102 productive hydraulic mines, 8 drift, and 46 surface placers, 156 in all, in 1912. The total gold output from deep mines in 1912 was 28,103.21 fine ounces, valued at $580,945.

The mine production of gold in fine ounces, with classification of ores and increase, for 1911 and 1912, follows:

Mine production of gold in Oregon in 1911 and 1912, by kinds of ore, in fine ounces.

Year.	Placers.	Deep mines.				Grand total.	
		Siliceous ore.	Copper ore.	Lead ore.	Total.	Quantity.	Value.
1911	8,140.25	22,080.33	420.48	.....	22,500.81	30,641.06	$633,407
1912	9,147.52	27,277.97	616.40	208.84	28,103.21	37,250.73	770,041
Increase (+) in 1912	+1,007.27	+5,197.64	+195.92	+208.84	+5,602.40	+6,609.67	+136,634

The gold production from different kinds of mines, by counties, for 1912, is given in the following table:

Source of gold production in Oregon, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ore.	Lead ore.	Total.	
Baker	1,830.22	21,389.87	195.39	.....	21,585.26	23,415.48
Coos	45.14	.....	.....	.....	.....	45.14
Crook	41.51	31.35	.....	.....	31.35	72.86
Curry	618.52	39.91	.....	.....	39.91	658.43
Douglas	539.91	144.16	.....	.....	144.16	684.07
Grant	561.73	486.70	.....	.....	486.70	1,048.43
Jackson	2,093.86	744.20	.....	208.84	953.04	3,046.90
Josephine	2,816.35	442.09	421.01	.....	863.10	3,679.45
Lane	.....	2,410.72	.....	.....	2,410.72	2,410.72
Malheur	511.95	1,588.97	.....	.....	1,588.97	2,100.92
Wheeler	88.33	.....	.....	.....	.....	88.33
Total	9,147.52	27,277.97	616.40	208.84	28,103.21	37,250.73
Increase (+) in 1912	+1,007.27	+5,197.64	+195.92	+208.84	+5,602.40	+6,609.67

The following table shows the output of placer gold, by classes of mines, in Oregon, by counties, in 1912:

Value of placer gold output in Oregon in 1912, by counties, by classes of mines.

County.	Hydraulic.	Drift.	Surface placers.	Total.
Baker	$27,256	$4,007	$6,571	$37,834
Coos	250		683	933
Crook			858	858
Curry	3,925		8,861	12,786
Douglas	8,827	2,013	321	11,161
Grant	10,813		799	11,612
Jackson	42,215		1,069	43,284
Josephine	48,258	6,741	3,220	58,219
Malheur	7,760		2,823	10,583
Wheeler	1,826			1,826
Total	151,130	12,761	25,205	189,096

The following table shows the increase or decrease in gold production in Oregon in 1912, by counties:

Increase or decrease in gold production in Oregon in 1912, by counties.

County.	Increase.	Decrease.
Baker	$94,255	
Coos		$587
Crook	1,292	
Curry	6,589	
Douglas	9,756	
Grant		15,668
Jackson	16,458	
Josephine		23,302
Lane	19,680	
Malheur	29,297	
Wheeler		1,136
Total	177,327	40,693
Net increase in 1912	136,634	

From the siliceous ore and old tailings treated in Oregon in 1912, the recovery of gold by processes was as follows: By amalgamation, $164,400; by cyanidation, $52,204. There are no chlorination plants, and as far as returns show, no concentrates were treated by cyanidation, but were shipped to smelters for treatment.

SILVER.

The yield of silver in Oregon in 1912 aggregated 57,081 fine ounces, valued at $35,105, an increase of 11,860 ounces in quantity and $11,138 in value, as compared with the production of 1911. Baker County in 1912 made the largest silver output, 39,140 ounces, valued at $24,071, a material increase in quantity and value as compared with 1911. Josephine County, next in rank, shows a production of 10,774 ounces, valued at $6,626. With the exception of Douglas, none of the other counties of the State produced as much as 2,000 ounces of silver. The placer mines of Oregon yielded 1,941 ounces, valued at $1,194, as compared with 1,257 ounces, valued at $666 in 1911. The deep mines yielded 55,140 ounces, valued at $33,911 in 1912; of this 10,555 ounces came from copper ores, and 567 ounces were from lead

ores, the remainder, 44,018 ounces, being derived from siliceous ore. An increase in the quantity of silver output in 1912 is shown from the placers, siliceous ore, copper ore, and lead ore, the total increase being 11,860 fine ounces. From the siliceous ore and old tailings treated in Oregon in 1912 the recovery of silver by amalgamation was $1,487, and by cyanidation, $239.

The source of silver, by kinds of ore and by counties, in 1912, is shown in the table following:

Source of silver production in Oregon, by kinds of ore, in 1912, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ores.	Lead ores.	Total.	
Baker	574	38,339	227	.....	38,566	39,140
Coos	10	.....	.....	.....	.....	10
Crook	11	109	.....	.....	109	120
Curry	89	8	.....	.....	8	97
Douglas	268	2,564	.....	.....	2,564	2,832
Grant	138	446	.....	.....	446	584
Jackson	361	521	.....	567	1,088	1,449
Josephine	389	57	10,328	.....	10,385	10,774
Lane	.....	1,655	.....	.....	1,655	1,655
Malheur	88	319	.....	.....	319	407
Wheeler	13	.....	.....	.....	.....	13
Total	1,941	44,018	10,555	567	55,140	57,081
Increase (+) in 1912	+684	+10,007	+602	+567	+11,176	+11,860

COPPER.

The mine production of copper in Oregon in 1912 was 260,429 pounds, valued at $42,971, an increase of 167,293 pounds in quantity and in value of $31,329 over the yield of 1911. The copper ore also carried gold to the value of $12,742 and silver to the value of $6,491.

LEAD.

There was no lead production in Oregon in 1911, but in 1912 the output was 39,317 pounds, valued at $1,768, from 2 mines, 1 in Jackson and 1 in Lane County.

THE MINING INDUSTRY IN OREGON IN 1912.

The great importance of the northeastern counties of the State, as compared with those of the southwestern portion, from a productive point of view, is rendered more impressive when it is remembered that the southwestern counties are considered an extension of the very productive California gold belt, and for over 50 years, mainly during the preponderance of the placer gold yield over that from quartz, this portion of the State yielded a considerable percentage of the total gold yield of Oregon.[1] The importance of total yield is not so marked in all the counties of northeastern Oregon as in Baker County, which stands ahead of all the counties of the State. And this prestige is not due, as in the early days of Oregon mining, to the output of placer mines, but to the output of quartz properties. As in California so in

[1] Diller, J. S., and Kay, G. F., Bull. U. S. Geol. Survey No. 340, 1908, p. 135.

Oregon, the productiveness of the deep and more permanent mines has, in later years, exceeded that of the more easily exhausted placers. More capital is required generally in the development, equipment, and maintenance of the deep mines than of the placers, and for this reason mainly Oregon mining has not progressed more rapidly.

An intelligent observer of the present mining conditions has noted the fact that in the southwestern portion of the State many mines are located on ground in the railroad grants, for which reason the miners are not trying to develop their properties any more than enough to hold possession until something is done to give the mine owner and prospector some assurance that his efforts will be rewarded without interference. Capital will not invest until this question of validity of title to mines on railroad grants is definitely settled.

The southwestern counties of Oregon, which form an extension of the California gold belt, are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. These counties (with the exception of Benton, which made no output) made in 1912 a combined production in gold of $217,565 and of $10,343 in silver. The production of placer gold in this region in 1912 was $126,383, an increase of $3,375, and the gold production from deep mines was $91,182, an increase of $25,219. This is the first time in some years than an increase of output from either placers or deep mines has been evident. In 1911 there was a decrease of $7,095 in placer gold; in 1910, a decrease of $55,149; in 1909, a decrease of $8,232; and in 1908, a decrease of $46,458. The decrease of gold yield from deep mines was $13,258 in 1911; $9,772 in 1910; $63,670 in 1909; and $99,376 in 1908.

Northeastern Oregon comprises the counties of Baker, Crook, Harney, Malheur, Umatilla, Union, Wallowa, and Wheeler. In 1912 the counties of Harney, Umatilla, Union, and Wallowa made no gold or silver output. The combined gold output of the 5 producing counties of this region, Baker, Crook, Grant, Malheur, and Wheeler, in 1912 was $552,476, of which Baker County alone contributed $484,041, or 87.6 per cent. This is an increase for 1912 of these counties, as compared with 1911, of $108,040. The placer-gold yield in 1912 was $62,713, an increase of $17,447 over the year 1911. The lode mines produced in gold $489,763 in 1912, as compared with $399,170 in 1911, an increase of $90,593 for 1912. The silver production of northeastern Oregon was 40,264 ounces in quantity, with a value of $24,762, an increase for 1912 of 6,846 ounces in quantity and of $7,050 in value. The placer-gold yield of these four counties in 1911 was $45,266; in 1910 it was $40,822, an increase of $4,756; in 1909 it was $43,043 less than 1908; and in 1908 it was $12,355 less than in 1907. The gold production from lode mines in 1911 was $399,170, a decrease of $30,172; in 1910 it was $429,342, a decrease of $42,311; in 1909 it was $63,670 less than in 1908; and in 1908 it was $105,784 less than in 1907.

The high price of platinum in 1912 called more attention to such gold-bearing sands near the mouths of the estuaries as contain significant quantities of platinum as a by-product of the ocean beach gold mining. Thus the beach inside of Coos Bay Head, on Coos Bay, is being worked for testing a centrifugal machine which is to throw both gold and platinum on the surface of carpeting with which the machine is lined. Ultimate success depends on the method of gathering the sand, which is said to be quite rich on and for a foot

above the shale bedrock, which is exposed and involves no stripping. The old beach at Whisky Run, Coos County, has been worked by various devices and usually with success. Lately it has been acquired with much adjacent high beach land for work on a large scale with a traveling beach dredge, which is capable of working the richer spots below high-water mark during calm weather and of changing to the gulch during storms. This gulch has been worked for years for gold, and considerable platinum has been wasted which it is now hoped to recover. The stretch of 6 miles or more of beach from Port Orford (Curry County) to Cape Blanco has been worked spasmodically for gold for many years. The sand contains the greatest proportion of platinum to gold known anywhere on the coast line. Frequently the value of the platinum yield exceeds that of the gold. This is owing to the fact that Sixes River, which empties in the stretch, drains several old beaches some miles in the interior, which are also being redeveloped at this time. In addition to modern concentrators, cheaper methods of collecting the sand are being installed, especially scrapers. At Gold Beach, south of the mouth of Rogue River, a new machine is being tested for saving both gold and platinum, which has been used with reported success on the fine gold in the sands of Snake River, Idaho. It keeps the heavy sand from caking during the concentration by means of a jig motion given to the water from a separate compartment. The method of cleaning up the concentrates is still to be determined. The ocean beach at Gold Beach is said to yield 40 cents a cubic yard at the surface and as high as $2 a cubic yard in the black sand at a depth of 15 feet. Some 39 ounces of platinum, valued at $1,003, came from the black sands of Oregon during the year 1912, incident to mining for gold.

The subdivision of tonnage and production of gold and silver in Oregon in 1912, according to methods of treatment, is shown in the following table:

Subdivision of tonnage and production of gold and silver in Oregon, in 1912, according to methods of treatment, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates treated.		
	Tonnage.	Gold.	Silver.		Tonnage.	Gold.	Silver.
	Short tons.		*Fine ozs.*	*Short tons.*	*Short tons.*		*Fine ozs.*
Baker	31,461	$124,876	1,169	10,130	2,533	$187,765	36,419
Crook							
Curry	85	825	8				
Douglas	78	2,360	62		11	413	2
Grant	1,283	7,844	273		43	930	135
Jackson	3,265	10,093	156		4	330	
Josephine	227	9,139	57				
Lane	8,054	42,537	839		120	7,297	816
Malheur	3,150	24,930	242		107	6,425	62
Total	47,603	222,604	2,806	10,130	2,818	203,160	37,434
Average per ton		4.68	$0.036			72.09	$8.17

Average recovery value (per ton) from both bullion and concentrates: Gold, $7.37; silver, $0.43.

Subdivision of tonnage and production of gold and silver in Oregon, in 1912, according to methods of treatment, by counties—Continued.

County.	Crude ore to smelter.			Old tailings treated.		
	Tonnage.	Gold.	Silver.	Tonnage.	Gold.	Silver.
	Short tons.		*Fine ozs.*	*Short tons.*		*Fine ozs.*
Baker	690	$81,656	659	28,350	$51,910	319
Crook	24	648	109	.....	.....	.....
Curry	.....	.....	.....	.....	.....	.....
Douglas	50	207	2,501	.....	.....	.....
Grant	17	1,162	37	100	125	.....
Jackson	110	9,278	932	.....	.....	.....
Josephine	3,854	8,703	10,328	.....	.....	.....
Lane	.....	.....	.....	.....	.....	.....
Malheur	17	1,492	15	.....	.....	.....
Total	4,762	103,146	14,581	28,450	52,035	319
Average value per ton	.....	$21.66	$1.88	.....	$1.83	$0.01

The total tonnage, by kinds of ore sold or treated, in each county in Oregon in 1912 is shown in the following table:

Subdivision of tonnage of ore sold or treated in Oregon in 1912, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Total ore.
Baker	69,916	715	.....	70,631
Crook	24	.....	.....	24
Curry	85	.....	.....	85
Douglas	128	.....	.....	128
Grant	1,400	.....	.....	1,400
Jackson	3,352	.....	23	3,375
Josephine	227	3,854	.....	4,081
Lane	8,054	.....	.....	8,054
Malheur	3,167	.....	.....	3,167
Total	86,353	4,569	23	90,945
Increase (+) or decrease (−)	−8,000	+364	+23	−7,613
Value per ton in gold or silver	$6.84	$4.21	$202.90	$6.76

The following table gives the number of producing mines, classified according to their chief product, in the counties of Oregon in 1912:

Number of mines, classified by chief product, in Oregon in 1912, by counties.

County.	Gold placer mines.				Deep mines.					Total producing mines.
	Hydraulic.	Drift.	Surface.	Total.	Gold.	Silver.	Copper.	Lead.	Total.	
Baker	14	3	9	26	20	.....	3	.....	23	49
Coos	1	.....	3	4	.....	.....	.....	.....	.....	4
Crook	.....	.....	1	1	1	.....	.....	.....	1	2
Curry	5	.....	7	12	2	.....	.....	.....	2	14
Douglas	11	2	2	15	4	1	.....	.....	5	20
Grant	13	.....	4	17	6	.....	.....	.....	6	23
Jackson	17	.....	4	21	7	.....	.....	1	8	29
Josephine	32	3	15	50	4	.....	2	.....	6	56
Lane	.....	.....	.....	.....	2	.....	.....	.....	2	2
Malheur	6	.....	1	7	1	.....	.....	.....	1	8
Wheeler	3	.....	.....	3	.....	.....	.....	.....	.....	3
Total	102	8	46	156	47	1	5	1	54	210

The following table shows the mine production of gold, silver, copper, and lead in Oregon in 1912, by counties, with the tonnage.

Production of gold, silver, copper, and lead in Oregon in 1912, by source and by counties.

County.	Ore treated.	Quartz gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ozs.*		*Fine ozs*		*Fine ozs.*	
Baker	70,631	21,585.26	$446,207	1,830.22	$37,834	23,415.48	$484,041
Coos				45.14	933	45.14	933
Crook	24	31.35	648	41.51	858	72.86	1,506
Curry	85	39.91	825	618.52	12,786	658.43	13,611
Douglas	128	144.16	2,980	539.91	11,161	684.07	14,141
Grant	1,400	486.70	10,061	561.73	11,612	1,048.43	21,673
Jackson	3,375	953.04	19,701	2,093.86	43,284	3,046.90	62,985
Josephine	4,081	863.10	17,842	2,816.35	58,219	3,679.45	76,061
Lane	8,054	2,410.72	49,834			2,410.72	49,834
Malheur	3,167	1,588.97	32,847	511.95	10,583	2,100.92	43,430
Wheeler				88.33	1,826	88.33	1,826
Total	90,945	28,103.21	580,945	9,147.52	189,096	37,250.73	770,041

County.	Quartz silver.		Placer silver.		Total silver.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Fine ozs.*	
Baker	38,566	$23,718	574	$353	39,140	$24,071
Coos			10	6	10	6
Crook	109	67	11	7	120	74
Curry	8	5	89	55	97	60
Douglas	2,564	1,577	268	165	2,832	1,742
Grant	446	274	138	85	584	359
Jackson	1,088	669	361	222	1,449	891
Josephine	10,385	6,387	389	239	10,774	6,626
Lane	1,655	1,018			1,655	1,018
Malheur	319	196	88	54	407	250
Wheeler			13	8	13	8
Total	55,140	33,911	1,941	1,194	57,081	35,105

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Baker	951	$157			$508,269
Coos					939
Crook					1,580
Curry					13,671
Douglas					15,883
Grant					22,032
Jackson			3,532	159	64,035
Josephine	254,380	41,973			124,660
Lane	5,098	841	35,785	1,610	53,303
Malheur					43,680
Wheeler					1,834
Total	260,429	42,971	39,317	1,769	849,886

REDUCTION MILLS IN OREGON IN 1912.

An investigation was made in 1912 as to the number of reduction mills in Oregon, with details of equipment and operation. A condensed statement of the result of this inquiry is shown as follows:

Total number of reduction mills in Oregon in 1912.

Mills.	Number of plants.	Crushers.	Number of stamps.	Roller mills.	Tube mills.	Concentrators.	Cyanide plants.	Capacity in 24 hours.
								Short tons.
Active mills	29	27	312	11	2	80	8	1,099
Idle mills	49	30	375	9	2	96	2	1,553
Total	78	57	687	20	4	176	10	2,652

This showing is not a very satisfactory one, as it appears that there are more idle mills and idle stamps than active ones. Moreover, the total daily capacity of the active mills is almost one-third less than that of the idle ones.

Reduction mills in Oregon in 1912, by counties.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
BAKER COUNTY.				*Short tons.*
Carpenter Hill [a]	Baker City	Amalgamation, concentration.	1 crusher, 5 stamps, 1 concentrator.	20
Highland	do	do	1 Dodge crusher, 2 roller mills, 1 Wilfley table, 1 Bartlett table, 7 Diester tables.	45
White Swan [a]	do	Amalgamation	1 crusher, 10 stamps	25
Virtue	do	Amalgamation, cyanidation.	1 Blake crusher, 20 stamps, 4 leaching and 4 percolation tanks.	55
Climax [a]	Bourne	Amalgamation, concentration, cyanidation.	1 crusher, 1 concentrator, 1 stamp (sampling mill).	5
North Pole	do	do	3 Blake crushers, 30 stamps, 1 Gruson ball mill, 6 Callow classifiers, 12 Frue vanners, 9 percolating and 9 agitation tanks.	100
Cracker-Oregon [a]	do	Amalgamation, concentration.	1 crusher, 10 stamps, 4 Johnson vanners.	50
South Pole [a]	do	Amalgamation	5 stamps	20
Last Chance	Cableville	Amalgamation, concentration.	1 crusher, 1 Huntington mill, 2 Johnson and 1 Wilfley tables.	20
Connor Creek [a]	Home P. O	do	1 Hendy crusher, 30 stamps, 4 Johnson vanners.	70
Mayflower [a]	Cornucopia	Amalgamation, concentration, cyanidation.	1 crusher, 10 stamps, 4 vanners, 7 ore tanks, 4 percolation and 3 agitation tanks.	40
Cornucopia	do	Amalgamation, cyanidation.	1 Gates crusher, 20 stamps, 2 tube mills, 2 Dorr classifiers, 14 ore tanks, 3 Pachuca agitation tanks, 2 Portland filters	100

[a] Idle in 1912.

Reduction mills in Oregon in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
BAKER COUNTY—con.				*Short tons.*
Norway [a]	Cornucopia	Amalgamation, concentration.	1 Huntington mill, revolving self-cleaning canvas table.	10
Queen of the West	do	do	1 Blake crusher, 10 stamps, 5 Frue vanners.	35
Cincinnati [a]	Durkee	do	1 Blake crusher, 4 stamps, 2 Wilfley and 1 Woodbury tables.	30
Bonanza	Greenhorn	do	1 crusher, 30 stamps, 1 Johnson and 1 Union vanner.	100
Golden Eagle	do	do	3 stamps, 1 Johnson table.	4
Snow Creek [a]	do	do	1 Blake crusher, 10 stamps, 1 Frue and 2 Wilfley vanners.	30
Dunn	Rye Valley	Amalgamation	3 stamps	6
Summit [a]	do	Amalgamation, concentration.	1 Blake crusher, 5 stamps, 1 New Standard concentrator	15
Rainbow	do	do	1 Blake crusher, 15 stamps, 1 Dorr classifier, 13 ore tanks, 3 Pachuca agitation tanks, 1 Paral filter.	80
Wilmot	do	Cyanidation, leaching.	4 ore tanks, 4 percolation tanks, 2 agitation tanks. (Worked tailings from Rainbow mine.)	35
Gem [a]	Sparta	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 4 Johnson concentrators.	30
Paddy Creek	do	Amalgamation	1 Blake crusher, 10 stamps	40
Columbia	Sumpter	Amalgamation, concentration, cyanidation.	1 Gates crusher, rolls and trummels, 20 stamps, 15 Johnson concentrators, 24 percolation tanks, 24 agitation tanks.	90
Golconda [a]	do	Amalgamation, concentration.	1 jaw crusher, 20 stamps, 4 Johnson vanners, 4 Christensen tables.	60
Jardine	do	do	1 Dodge crusher, 3 stamps, 1 Johnson table.	12
Mammoth	do	do	1 Blake crusher, Bryan mill, 1 Johnson table.	18
Gleeson [a]	Weatherby	Amalgamation	5 stamps	15
Little Hill	do	do	2 stamps	6
Bonanza	do	do	3 stamps	9
CLACKAMAS COUNTY.				
Ogle Mountain [a]	Elkhorn	do	1 crusher, 10 stamps	60
CROOK COUNTY.				
Mayflower	Howard	Amalgamation, concentration, cyanidation.	1 Blake crusher, 5 stamps, 1 Wilfley table, 30-ton cyanide plant.	20
COOS COUNTY.				
Salmon Mountain	Myrtle Point	Amalgamation, concentration.	1 crusher, Little Giant mill, 1 Wilfley table.	2
CURRY COUNTY.				
Lucky Boy [a]	Marial	do	1 crusher, 2 stamps, 1 Wilfley table.	5
DOUGLAS COUNTY.				
Mayflower	Champion, Clackamas County.	Amalgamation, concentration, cyanidation.	1 Climax crusher, 5 stamps, 1 Frue vanner, 2 ore and percolation tanks.	15

[a] Idle in 1912.

Reduction mills in Oregon in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
CURRY COUNTY—contd.				*Short tons.*
Glendale[a]	Glendale	Amalgamation, concentration, cyanidation.	5 stamps, 1 Standard concentrator, 4 cyanide tanks.	15
Union Leader[a]	do	Amalgamation, concentration.	1 Nissen mill, 1 Eccleston table.	5
A. F. & A. M.[a]	Myrtle Creek	do	1 Tadmor mill, plate amalgamation, 2 Standard tables.	20
GRANT COUNTY.				
Black Butte[a]	Beach Creek	Amalgamation	1 roller mill, 5 stamps	30
Ben Harrison	Granite	Amalgamation, concentration.	1 crusher, 20 stamps, 2 classifiers, 10 Isbel vanners, 4 Overstrom tables.	100
Cougar[a]	do	Amalgamation, cyanidation.	1 crusher, 2 rolls, 6 ore tanks, 3 percolation and 3 agitation tanks, 2 filters.	120
Alamo[a]	do	Amalgamation, concentration.	1 Gates crusher, 10 stamps, 2 Johnson vanners.	35
Monumental[a]	do	Amalgamation	1 crusher, 10 stamps	40
Morning	Austin	Amalgamation, concentration.	Bryan mill, 1 Johnson concentrator.	10
Myrtle[a]	Greenhorn, Baker County.	Amalgamation	3 stamps	5
Virginia[a]	do	Amalgamation, concentration.	1 Blake crusher, 10 stamps, 1 Standard table.	25
Royal White	do	do	2 Tremain steam stamps, Frue vanners.	10
Jupiter[a]	John Day	Amalgamation	20 stamps	80
Dixie Meadows	Prairie City	Amalgamation, concentration.	1 crusher, 10 stamps, 5 concentrators.	25
Equity	do	do	5 stamps, 1 New Standard concentrator.	10
Present Need	do	Amalgamation	1 crusher, 10 stamps	40
Standard[a]	do	Amalgamation, concentration.	1 crusher, 2 Sturtevant roller mills, 3 Wilfley and 2 Bartlett concentrators.	50
Red Boy	Red Boy	Amalgamation, cyanidation.	1 crusher, 20 stamps, 75-ton cyanide plant.	80
JACKSON COUNTY.				
Star[a]	Applegate	Amalgamation, concentration.	1 Gates crusher, 5 stamps, 2 Johnson vanners.	15
Ashland[a]	Ashland	do	1 Gates crusher, 10 stamps, 2 Frue vanners.	30
Bula[a]	do	Amalgamation	1 Martin crusher, Lane mill.	20
Shorty Hope[a]	do	Amalgamation, concentration.	1 crusher, 10 stamps, 4 Frue vanners.	40
Lucky Bart	Gold Hill	do	5 stamps, 1 Johnson concentrator.	15
Norling	Jacksonville	do	5 stamps, 1 Jacobs concentrator.	20
Opp	do	Amalgamation, concentration, cyanidation.	1 crusher, 20 stamps, 1 Dorr classifier, 1 Wilfley and 6 Johnson concentrators, 4 ore tanks, 4 percolation tanks, 2 agitation tanks, 2 Oliver filters.	60
Buzzard	Trail	Amalgamation, concentration.	3 stamps, 1 Johnson concentrator.	8
JOSEPHINE COUNTY.				
Mountain Lion	Murphy	Amalgamation, concentration.	1 Blake crusher, 5 stamps, 1 Wilfley table.	12
Sugar Pine[a]	Galice	do	1 crusher, 10 stamps, 2 vanners.	40
Capital City[a]	Grants Pass	do	1 crusher, Hendy 2-stamp mill, 2 Frue vanners.	6

[a] Idle in 1912.

Reduction mills in Oregon in 1912, by counties—Continued.

Name.	Post office.	Process.	Equipment.	Approximate maximum capacity per day.
JOSEPHINE COUNTY—continued.				*Short tons.*
Mount Pitt[a]	Grants pass	Amalgamation, concentration.	1 crusher, 10 stamps, 1 Frue vanner, 1 Pinder table.	10
Granite Hill[a]	do	do	20 stamps, 6 Frue vanners	90
Gold Drift[a]	do	do	1 crusher, 5 stamps, 4 Wilfley tables.	30
Brooklyn[a]	Holland	do	2 stamps, 1 Wilfley concentrator.	6
Michigan	Murphy	do	1 Sturtevant crusher, 5 stamps, 3 Callow classifiers, 2 Monell concentrators.	12
Gold Note[a]	Placer	Amalgamation	3 stamps	5
Greenback	do	Amalgamation, concentration, cyanidation.	3 jaw crushers, 40 stamps, 5 Johnson concentrators, 4 steel percolation tanks, 1 steel ore tank.	100
Hammersley[a]	do	Amalgamation	5 stamps	10
Tough Nut[a]	do	do	3 stamps	6
LANE COUNTY.				
Blue Bird	Blue River	do	1 crusher, Denver quartz roller mill.	24
Lucky Boy[a]	do	Amalgamation, concentration, cyanidation.	1 Giant crusher, 40 stamps, 4 Frue and 6 Wilfley vanners, 5 ore tanks, 2 agitation tanks, 2 home-made filters.	100
Treasure[a]	do	Amalgamation, concentration.	1 crusher, 12 stamps, 1 vanner.	50
West Coast	Champion, Clackamas County.	do	2 crushers, 30 stamps, 4 Wilfley tables.	50
Vesuvius	Bohemia	do	1 Blake crusher, 10 stamps, 2 Standard tables.	30
Star[a]	Cottage Grove	Amalgamation	5 stamps	15
Sweepstake[a]	Bohemia	do	2 stamps	5
MALHEUR COUNTY.				
Red, White and Blue	Malheur	Amalgamation, concentration.	1 crusher, 6 stamps, 2 Johnson vanners.	30
Humboldt	Rye Valley, Baker County.	do	1 crusher, 10 stamps, 6 Johnson vanners.	35
MARION COUNTY.				
Mayflower[a]	Gates	Amalgamation	2 stamps (light)	1

[a] Idle in 1912.

Summary of active reduction mills in Oregon in 1912, by counties.

County.	Number of plants.	Crushers.	Stamps.	Roller mills.	Tube mills.	Concentrators.	Cyanide plants.	Capacity in 24 hours.
								Short tons.
Baker	16	14	169	10	2	47	5	720
Coos	1	1		1		1		2
Crook	1	1	5			1		20
Douglas	1	1	5			1	1	15
Grant	4	1	33			10	1	103
Josephine	3	5	50			8	1	124
Lane	2	3	40			6		80
Malheur	1	1	10			6		35
Total	29	27	312	11	2	80	8	1,099

Summary of idle reduction mills in Oregon in 1912, by counties.

County.	Number of plants.	Crushers.	Stamps.	Roller mills.	Tube mills.	Concentrators.	Cyanide plants.	Capacity in 24 hours.
								Short tons.
Baker	14	11	125	1	.....	30	2	420
Clackamas	1	.....	10	.....	.....	.....	.....	60
Curry	1	1	2	.....	.....	1	.....	5
Douglas	3	.....	6	1	.....	4	.....	40
Grant	10	6	80	5	.....	23	.....	495
Jackson	4	4	25	1	.....	8	.....	105
Josephine	9	4	60	.....	.....	17	.....	203
Lane	5	3	59	1	.....	11	.....	194
Malheur	1	1	6	.....	.....	2	.....	30
Marion	1	.....	2	.....	.....	.....	.....	1
Total	49	30	375	9	.....	96	2	1,553

PRODUCTION BY COUNTIES.[1]

BAKER COUNTY.

Mine production of gold, silver, and copper, in Baker County, Oreg., 1905–1912.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	37	75,053	$771,607	55,161	3,200	$805,423
1906	51	58,889	795,653	53,708	185	736,673
1907	46	69,881	631,045	69,589	.....	676,974
1908	50	38,413	507,929	17,495	.....	517,202
1909	42	32,521	417,538	19,514	.....	427,685
1910	54	56,263	401,002	29,835	13,861	418,873
1911	34	74,558	389,786	30,944	.....	406,186
1912	49	70,631	484,041	39,140	951	507,269
Increase (+) or decrease (−) in 1912	+15	−3,927	+94,255	+8,196	+951	+101,083

The total value of all the metals mined in Baker County in 1912 was $507,269, as compared with $406,186 in 1911, an increase of $101,083 for 1912. There was less tonnage treated, but the gold yield of the county of $484,041 was $94,255 more than in 1911. The silver increased by 8,196 ounces in quantity and was valued at $24,071, as compared with $16,400 in 1911. In 1912 there was the small production of 951 pounds of copper, valued at $157, but there was no output of this metal in 1911. There were 49 producing mines in the county in 1912, an increase of 15 for the year as compared with 1911. The placers numbered 26, of which 14 were hydraulic, 3 were drift, and 9 were sluicing mines. The placers combined yielded $37,834 in gold and 574 ounces of silver, valued at $353, as compared with $17,381 in gold and 178 ounces of silver in 1911. The total number of producing deep mines was 23. The total output of siliceous ore mined and treated in the county was 69,916 tons, or 4,642 tons less than in 1911. The gold yield of this ore was valued

[1] For reference to United States Geological Survey publications on the mining districts of Oregon, see Hill, J. M., The mining districts of the western United States: Bull. U. S. Geol. Survey No. 507, 1912.

at $442,168 and the silver yield was 38,339 fine ounces, valued at $23,578. The average value of the ore per ton was $6.32 in gold and 34 cents in silver, a total of $6.66 per ton, in 1912, as compared with $4.99 in gold and 22 cents in silver, or $5.21 per ton, in 1911, and $6.93 in gold and 3 cents in silver, a total of $6.96 per ton, in 1910. Of the total of 69,916 tons of siliceous ore, 31,461 tons were treated at gold and silver mills and yielded $124,876 in gold and 1,169 ounces of silver (valued at $719), by amalgamation, an average value per ton of $3.97 in gold and 2 cents in silver. From the 31,461 tons of milling ore were derived 787 tons of concentrates, yielding $115,021 in gold and $3,768 in silver, a total value of $118,789, or an average value of $150.94 per ton. The total yield of the milling ore from the plates and the concentrates was $239,897 in gold and $4,487 in silver, an average of $7.62 per ton in gold and 14 cents in silver, a total recovery of $7.76 per ton in gold and silver. In addition to this there were 10,130 tons of ore sent to concentrating mills which yielded 1,746 tons of concentrates, valued at $72,744 in gold and $18,630 in silver, an average value per ton in gold and silver of $52.33. Crude ore was shipped to smelters to the amount of 690 tons, and yielded in gold $81,656 and in silver 659 ounces, valued at $405, a total value for the smelting ores of $82,061, or an average of $118.93 per ton. In addition to this there were 28,350 tons of old tailings treated, yielding $51,910 in gold and 319 ounces of silver, valued at $196, an average value of $1.84 per ton in gold and silver.

Baker district.—The mines at Baker and Virtue are included in this district. There were 6 productive deep mines and 5 productive placers in 1912, their yield being $5,841 in placer gold and $63 in placer silver and $77,215 in gold from deep mines, with $18,541 in silver, a total of gold and silver of $101,660. Of the deep mines, the Baisley-Elkhorn made a nominal yield, and the Highland was the most productive mine in the district. This property is developed by about 8,000 feet of tunnels and upraises. The 60-ton concentration mill was completed during 1912 and operated continuously after May 1, the concentrates being shipped to the Tacoma smelter. At the Virtue mine a hydroelectric power plant was added. The other deep mines were small producers. The placers of the district are all small sluicing mines.

Burnt River district.—Only placers are worked in this district. the Clark Creek Farm Co., Johnson, Pine Creek, and Porter having made a combined output of $2,375 in gold and silver. Some prospecting is going on with a view of installing a dredge on Burnt River in this district.

Cable Cove district.—The Blue Mountain was the only productive property in this district. The experimental reduction plant began operations in September, 1912.

Cornucopia district.—Three deep mines and 1 placer in this district made a combined output of $94,379 in gold and silver in 1912. The Queen of the West, Cornucopia, and Paddy's Creek are the deep mines. The Cornucopia is opened by a 1,200-foot adit and a 500-foot shaft, and, in addition to the shaft sinking, 1,200 feet of drifts and raises were made during the year. The old mill was operated until June, since when a new mill with a 100-ton cyanide plant has been

installed. The only placer mine is the Boulder Creek, which is quite productive and is worked both by hydraulicking and drifting.

Connor Creek district.—Two small sluicing mines and 1 drift mine were placer producers in this district in 1912, and there were no operating deep mines.

Cracker Creek district.—There were 5 deep mines and 2 placers producing in this district in 1912, with a combined gold and silver yield in 1912 of $266,277. The placers are the Buck Gulch and the Independence at Sumpter. The deep mines are the Columbia (the most productive mine in Oregon), Golden Chariot, Mammoth, Northwestern, and Eastern Oregon (North Pole). These deep mines produced nearly all the gold of the district in 1912.

Durkee, Granite, and Greenhorn districts.—In Durkee district there was only 1 small deep mine producing; and in Granite there was 1 productive placer. In the Greenhorn district were 2 deep mines and 1 placer, none with any large production.

Mormon Basin and Pine Creek districts.—The 2 deep mines in Mormon Creek district producing were the Commercial (Rainbow), and Deer Creek & May Queen. At the Commercial a 75-ton amalgamation and cyanide plant was built in 1912, and a power line was constructed for a 22,000-volt circuit. The Wilmot cyanide plant has worked up the old tailings at Rye Valley and closed down indefinitely. The Deer Creek was only worked two months during 1912. The output of Mormon Basin district in 1912 was $23,515 in gold and silver. In Pine Creek district the Gold Nugget, Red Dog, Jay, and Hamm hydraulic mines were small producers.

Rye Valley, Sumpter, Unity, Weatherby, and Whitney districts.—In Rye Valley district there was 1 productive placer mine in 1912; in Sumpter, 1 deep mine; in Unity, 1 placer; in Weatherby, 2 deep mines; and in Whitney, 2 placers. The combined output of these districts in 1912 in gold and silver was only $8,199.

The Powder River Gold Dredging Co., near Sumpter, in this county, constructed a gold dredge during 1912, but did not begin operations until January 7, 1913. It is owned by successful dredge mining men of San Francisco, Cal.

COOS AND CROOK COUNTIES.

Coos County made a production of $933 in gold and $6 in silver in 1912, as compared with $1,520 in gold and $7 in silver in 1911. The producing mines were all placers, and were the Whiskey Run, in Whiskey Run district; the Buckeye Bar and Flanagan Bar, in Johnson Creek district; and the Salmon Mountain, in Sixes River district. An output of $1,580 in gold and silver from Crook County was derived from 2 placer mines.

CURRY COUNTY.

The production of gold in Curry County in 1912 was $13,611, and of silver, 97 ounces, a total of $13,671 in value, this being from 12 placers and 2 deep mines. The most productive mine in the county is the Kalamazoo ocean beach sand mine in Ophir district, near Corbin. In Chetco district the Golden Dream hydraulic mine is being

operated near Harbor.[1] At Gold Beach are the Bailey's Head & Woodruff and Ophir Beach mines. In Elk Creek district are the Myrtle, Elk & Kate, Elk River, Sullivan, and Waters-Kelly mines, all small producers. In Mule Creek district there were 2 deep mines and 2 productive placers. In Rogue River district were 2 small placers, and at Sixes River there was only 1 placer producing.

DOUGLAS COUNTY.

Douglas County in 1912 made a production of $14,141 in gold, and 2,832 ounces of silver, valued at $1,742, with a total value of $15,883, as compared with $4,385 in gold and 78 ounces of silver in 1911, with a total value of $4,426. In 1912 there were 5 productive deep mines and 15 placers. The quartz gold was valued at $2,980 and the placer gold at $11,161. In Bohemia district only 1 small deep mine was productive, and 1 placer in Canyonville district. Cow Creek district was the most productive in the county, with 1 deep and 4 placer mines. The placer mines are the Douglas, McGregor, and Oregon, and the combined output of all the mines of the district in 1912 was valued at $6,559. In Green Mountain district there were 5 producing hydraulic mines, the Boulder, Booth (or Hogan), Miser, Starvout Nugget, and Sanders. In Myrtle Creek district were 3 productive placers, all small ones, and Ollala, Perdue, and Poker Flat districts have 1 productive placer each. Only 128 tons of ore were worked from the deep mines of the county in 1912.

GRANT COUNTY.

The production of Grant County in 1912 was $21,673 in gold and 584 ounces of silver, valued at $359, with a total value of $22,032, as compared with $38,571 in 1911. There were 6 deep and 17 placer mines producing in the county in 1912. The deep mines produced 1,400 tons of ore, yielding $10,061 in gold and 446 ounces of silver, and the placers produced $11,612 in gold and 138 ounces of silver. In Beech Creek district there was 1 productive placer, the Black Butte, and there was only 1 also in Bull Run district, the Gold Center. Canyon Mountain district had 6 productive placers, the Caledonia, Fitch, Gray Eagle, Humboldt, Quartz Gulch, and small mines, with a combined yield of $6,380 in gold and silver, making this the most productive district in the county. In Elk Creek district there were 2 placers, 3 in Granite district, and Poker Flat district had 2, all small producers. In Quartzburg district are the following deep mines, all productive in 1912 to a small extent: Bull Run, Dixie Meadows, Equity, and Present Need. Their combined output in gold and silver was valued at $4,571. There was 1 producing deep mine in Red Boy district, the Red Boy. In Susanville district there were only 2 productive mines, both small placers.

[1] See Day, D. T., and Richards, R. H., Black sands from placer mines: Bull. U. S. Geol. Survey No. 285, 1906, pp. 150–164. Kemp, J. F., The geological relations and distribution of platinum and associated metals: Bull. U. S. Geol. Survey No. 193, 1902, pp. 51–53.

JACKSON COUNTY.

In Jackson County there were 8 productive deep mines and 21 placers; of the latter 17 are hydraulic and 4 are sluicing mines. The placers yielded $43,284 in gold and 361 ounces of silver, with a total value of $43,506, and the deep mines yielded $19,701 gold, 1,088 ounces of silver, and 3,532 pounds of lead, having a total value of $20,529. The value of the output of the county in 1912 was $64,035, as compared with $46,928 in 1911.

In Applegate district the El Senora Co. had a small production from "specimen rock" in 1912, and put up a 10-stamp mill, for which they have 2,500 tons of ore ready for crushing. The Layton & Pittock claims are both operated by the hydraulic system. In Blue Ledge district there is 1 deep mine and in Evans Creek district 1 hydraulic mine. Foots Creek district had 3 productive deep mines and 5 placers. The Gold Ridge has been producing shipping ore, which was sent to the Mammoth smelter in California, but a 2-stamp mill was constructed in 1912. The Hattie & Annie mine supplied ore to a custom mill. The Lucky Bar is the largest producer of the deep mines in the district. The placers are all hydraulic mines and are the Iron Gulch, Black Channel, Cook, Glen Ditch, and Sperry or Maybright. The total output of the district in 1912 was $5,434 in gold and silver.

Forest Creek district produced during the year $10,992 in gold and silver from the following hydraulic mines: Forest Creek, Pearce, Ray, Sturgis, and Spaulding.

A small output was made by one mine in Galls Creek district.

Jacksonville district made a yield for the year of $16,219 in gold and silver from 3 deep mines and 1 small sluicing mine. The deep mines are the Medford, Opp, and Buzzard. The largest output from any mine in the county in 1912 was by the Pleasant Creek, where the ancient river bed channel was worked by hydraulicking.

JOSEPHINE COUNTY.

The total output of gold, silver, and copper in Josephine County in 1912 was valued at $124,660 as compared with $115,245 in 1911, an increase of $9,415. The gold yield was $76,061, the silver 10,774 ounces, valued at $6,626, and the copper 254,380 pounds, valued at $41,973. The copper output in 1911 was 82,808 pounds. The 6 deep mines of the county produced 4,081 tons of ore in 1912, all, except a few hundred tons, being copper ore. The output from these combined deep mines was 863.10 fine ounces of gold, valued at $17,842; 10,385 ounces of silver, valued at $6,387; and 254,380 pounds of copper, valued at $41,973. The value of the deep-mine output of the county was therefore, in all metals, $66,202. The 50 productive placer mines in 1912 yielded 2,816.33 fine ounces of gold, valued at $58,219 and 389 ounces of silver, valued at $239, a total value of $58,458. Of the placer gold, $48,258 came from hydraulic mines, $6,741 from drift mines, and $3,220 from sluicing mines. In 1912 the gold placer yield decreased $28,338. There was, however, an increase of gold output from the deep mines of $5,036, so that the total decrease in gold production of the county was $23,302, the largest decrease among the counties of the State.

Of the ore produced in the county, 227 tons were treated at gold and silver mills, and 3,854 tons were shipped to smelters. The falling off in tonnage of ore mined and treated was 1,243 tons in 1912, as compared with 1911, yet there was an increase of gold yield from ore in 1912, as shown, the decrease of gold output for the year being due to the placer output.

A table follows which shows the output of gold and silver from the various mining districts of Josephine County in 1912. In this table, however, it is to be noted that the value of copper in both Galice and Waldo districts is deducted from the totals of those districts, in order to conceal individual yield of certain mines, this copper value being added at the bottom of the table so that the figures shall balance and the grand total be correct.

Value of output of Josephine County (Oreg.) mining districts in 1912.

District.	Placer gold.	Quartz gold.	Placer silver.	Quartz silver.	Copper.	Total.
Althouse	$3,116		$17			$3,133
Applegate	315		2			317
Briggs Creek	5,723		24			5,747
Galice	1,139	$5,809	7	$4,969		11,924
Grave Creek	19,650	395	74	4		20,123
Illinois	3,222		14			3,236
Jump-Off-Joe	6,615	7,235	29	26		13,905
Louse Creek	310		2			312
Pickett Creek	1,779		5			1,784
Rogue River	4,115		17			4,132
Sucker Creek		1,509		5		1,514
Waldo	6,634	2,894	15	1,383		10,926
Williams	2,660		15			2,675
Wolf Creek	2,755		17			2,772
Sweat Basin	186		1			187
					41,973	41,973
Total	58,219	17,842	239	6,387	41,973	124,660

The producing mines in the Althouse district are all placers and are the Deadwood Gulch, Goldsby, Mount Bullion, Little Homestead, Rambler, Slide, and Siskiyou.

In the Josephine County portion of Applegate district the Oscar Creek Mining Co. made a small production by sluicing.

In Briggs Creek district are the Old Channel hydraulic and the Stone sluicing mine.

In the Galice district the Almeda Consolidated Mining Co. has a 100-ton smelter, but it only ran 30 days in 1912. The matte is sold to the Tacoma Smelting Co. The Colvin hydraulic mine was also productive in this district.

In Grave Creek district there were 1 productive deep mine and 10 placers. The placers are mainly hydraulic mines and are the Archer, Cracker Jack, Goff-Abbott, Ideal, Reid, and McMickle.

In Illinois district are the Morrison and Wilson & Anderson hydraulic mines.

Jump-Off-Joe district has 5 mines, 2 deep and 3 placers.

In Louse Creek district 2 placers made a small output, and in Pickett Creek district the Hellgate and the Flanagan mines were productive.

Rogue River district had 4 placer producers in 1912, the Copsey, Dean & Corliss, Gold Bar & Rocky Gulch hydraulic mines, and the Crescent sluicing mine.

In Sucker Creek district 1 deep mine only is operating.

Waldo district has one large producer, the Elder Mining & Smelting Co., which ships its copper ore to the Mammoth Copper Mining Co. in Shasta County, Cal. The Alder Gulch, Fry Gulch, and Logan placer mines are also productive in this district.

At Williams district the producing placers were the Watts, Smith, Powell Creek, and Williamsburg. Wolf Creek also had placers only—the Copper Knob, Ruble, Sarah Bell, and Lehman mines.

In Sweat Basin district there was only 1 small producing sluicing mine.

The water season of 1912 in Oregon was very short, most of the placer mines having short supply for washing gravel, for which reason not only from Josephine but from other counties, there was reported a comparatively small gold yield for the year.

LANE COUNTY.

In 1912 Lane County produced 2,410.72 fine ounces of gold, valued at $49,834; 1,655 ounces of silver, valued at $1,018; 5,098 pounds of copper, valued at $841; and 35,785 pounds of lead, valued at $1,610, a total value of $53,303, as compared with $30,401 in 1911, when no copper or lead was produced. This shows an increase in value of output of $22,902, of which $19,680 was in gold. The entire output in Bohemia district came from deep mines, the principal one of which is the West Coast mine, which is opened by a 1,000-foot tunnel and has a 30-stamp mill. No important changes have occurred at the mine, except that black sulphide ore is reported and seems to continue as greater depth is attained.

MALHEUR AND WHEELER COUNTIES.

The total yield from Malheur County in 1912 from 1 deep mine and 7 placers was $43,430 in gold and 407 ounces of silver, valued at $250, a total of $43,680, as compared with $15,491 in 1911, an increase of $28,189. The gold increased by $29,297 in 1912, but there was no copper production in 1912 as in 1911. The mines are all in Mormon Basin district, the most important being the Humboldt Consolidated, one of the large deep producers of the State. The entire plant was changed from steam to electric power ready for work in 1913. A fine ore body has been reported on the third level. The placer mines are all hydraulic and are the Colt Bros., Glengarry, Harper, Lutz, and Quartz Gulch.

In Wheeler County the total gold yield was $1,826 and that of silver 13 ounces, valued at $8, a total of $1,834, as compared with $2,997 in 1911, a decrease for 1912 of $1,163. The mines are all placers, are in Spanish Gulch district, and are the Mule Gulch, Spanish Gulch, and Sand Gulch properties.

SOUTH DAKOTA.

By Charles W. Henderson.

PRODUCTION.

The total value of the production of gold, silver, and lead in South Dakota for 1912, as reported from 40 productive mines, 19 of which were placers, amounted to $8,019,371. This is the largest production in any one year, the output being $229,183 above the previous maximum mine yield of $7,790,188 in 1908 and $468,613 larger than that of 1911. The gold output was 381,745.02 fine ounces, valued at $7,891,370—over 98 per cent of the total value. The increase in gold yield for the year was 21,841.12 fine ounces in quantity and $451,496 in value. The production of silver also increased from 203,755 to 206,460 fine ounces. Smelting ore from South Dakota in 1912 carried 22,845 pounds of lead, against 64,311 pounds in 1911. Placer gold increased from 584.03 fine ounces in 1911 to 663.95 ounces in 1912. Some of the placer gold was sold for use in the arts.

The total quantity of ore mined and treated in 1912 was 1,901,726 short tons, averaging 0.20 ounce, or $4.14 in gold, as compared with 1,946,127 short tons, averaging $3.817 in 1911, and with 1,523,929 short tons, averaging $3.543 in 1910. There were 1,893,836 tons treated in the mills of the State, yielding as bullion $7,734,806 in gold and 179,335 fine ounces of silver, valued at $110,291, a total value of $7,845,097, or an average recovery per ton of $4.08 in gold and of $0.058 in silver, as compared with $3.77 in gold and $0.05 in silver in 1911. The quantity of crude ore shipped to smelters amounted to 7,890 tons, having an average content in gold of 0.8758 ounce, or $18.10 per ton, and of 3.43 ounces in silver.

Tonnage of ore to gold and silver mills, with quantity of gold and silver contained in bullion produced in South Dakota in 1912, by processes.

Ore to gold and silver mills.		Process.	Gold in bullion.	Silver in bullion.
			Fine ounces.	*Fine ounces.*
1,529,834	short tons	Amalgamation	241,502.44	70,129
1,827,080[a]	do	Cyanidation	132,668.78	109,206
Total			374,171,22	179,335

[a] Contains 1,463,078 tons tailings from part of tonnage amalgamated.

Consumption of quicksilver and cyanide in South Dakota mills in 1912.

Quicksilver.	Potassium cyanide.	Sodium cyanide.
Pounds.	*Pounds.*	*Pounds.*
[a] 14,095	[b] 139,657	[b] 439,974

[a] Represents 1 pound of mercury per 17.13 ounces of gold; or, 1 ounce of mercury per 1.07 ounces of gold; and 1 pound of mercury per 109 tons of ore.

[b] Potassium and sodium cyanide combined were used at a ratio of 0.32 pound of cyanide per ton of ore or tailings treated, and for every pound used there was recovered 0.23 ounce of gold.

Mine production of gold, silver, and lead in South Dakota in 1911 and 1912.

Year.	Number of mines producing.	Tonnage.	Gold.[a]		Silver.[a]		Lead.		Total value.
			Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*		
1911	37	1,946,127	359,903.90	$7,439,874	203,755	$107,990	64,311	$2,894	$7,550,758
1912	40	1,901,726	381,745.02	7,891,370	206,460	126,973	22,845	1,028	8,019,371
Increase (+) or decrease (−)	+3	−44,401	+21,841.12	+451,496	+2,705	+18,983	−41,466	−1,866	+468,613

[a] Includes placer production.

Production of gold and silver in South Dakota from 1876 to 1912, inclusive.

Year.	Gold.	Silver.		Total commercial value.
	Value.	Fine ounces.	Commercial value.	
1876	[a]$1,200,000	3,867	$4,486	$1,204,486
1877	[a] 2,000,000	6,187	7,424	2,007,424
1878	[a]2,250,000	7,734	8,894	2,258,894
1879	[a]2,500,000	7,734	8,662	2,508,662
1880	[b]3,305,843	[d] 54,770	[i] 62,986	3,368,829
1881	[b] 4,000,000	54,141	61,179	4,061,179
1882	[b]3,300,000	135,352	154,301	3,454,301
1883	[b]3,200,000	116,016	128,778	3,328,778
1884	[b]3,300,000	116,016	128,778	3,428,778
1885	[b]3,200,000	77,344	82,758	3,282,758
1886	[b]2,700,000	328,711	[j]325,424	3,025,424
1887	[b]2,400,000	417,656	[j]409,303	2,809,303
1888	[b]2,600,000	[d]77,344	72,703	2,672,703
1889	[b]2,900,000	[d]50,000	47,000	2,947,000
1890	[b]<3,200,000	[d]100,000	105,000	3,305,000
1891	[b]3,550,000	[d]100,000	99,000	3,649,000
1892	[b]3,700,000	[d]60,000	52,200	3,752,200
1893	[d]4,006,400	[d]140,400	109,512	4,115,912
1894	[d]3,868,155	[d]58,973	37,153	3,905,308
1895	[d]3,869,500	[d]159,300	103,545	3,973,045
1896	[d]4,969,800	[d]229,500	156,060	5,125,860
1897	[d]5,694,900	[d]147,600	88,560	5,783,460
1898	[d]5,699,700	[d]152,300	89,857	5,789,557
1899	[d]6,469,500	[d]145,600	87,360	6,556,860
1900	[d]6,177,600	[d]536,200	[d k]332,444	6,510,044
1901	[d]6,479,500	[d]78,000	[d]46,800	6,526,300
1902	[d]6,965,400	[d]340,200	[d]180,306	7,145,706
1903	[d]6,826,700	[d]221,200	[d]119,448	6,946,148
1904	[e]7,363,977	[e]161,611	[l]93,734	7,457,711
1905	[e]6,989,492	[e]182,749	[l]111,477	7,100,969
1906	[e]6,841,469	[e]150,875	[l]102,595	6,944,064
1907	[e]4,138,189	[e]93,895	[e]61,971	4,200,160
1908	[e]7,657,376	[e]248,762	[e]131,844	7,789,220
1909	[e]6,577,836	[e]194,273	[e]101,022	6,678,858
1910	[e]5,402,257	[e]118,800	[e]64,152	5,466,409
1911	[e]7,439,874	[e]203,755	[e]107,990	7,547,864
1912	[e]7,891,370	[e]206,460	[e]126,973	8,018,343
Total	170,634,838	5,483,325	4,011,679	174,646,517

[a] Black Hills, S. Dak., by the Black Hills Mining Men's Association, 1904.

[b] Emmons, S. F., Progress of the precious-mineral industry in the United States since 1880; Mineral Resources U. S. for 1892, U. S. Geol. Survey, 1893, p. 71. Estimate of the Director of the Mint.

[c] A canvass of the mines by the Eleventh Census gives $3,091,137.

[d] Mineral Resources U. S., U. S. Geol. Survey. Estimated by the Director of the Mint.

[e] Mineral Resources U. S., U. S. Geol. Survey. Collected by the United States Geological Survey from the mines.

[f] Report of the Director of the Mint for 1880, p. 192, gives for the fiscal year 1879: Gold, $2,420,000; silver, $10,000.

[i] Report of the Director of the Mint for 1880, p. 162, records first output (in latter part of 1879) of silver from the Florence silver chlorination mill and of shipments to Omaha of silver ore.

[j] Due to production of Iron Hill lead-silver mine. Report Director of the Mint for 1887, p. 197.

[k] Due to the treatment at the Deadwood and Delaware smelter of accumulated silver-bearing ore (of the Golden Reward mine) not desirable to treat by chlorination process. Franklin R. Carpenter, Report Director of the Mint for 1900, p. 185.

[l] Previous figures of U. S. Geol. Survey give, respectively, $92,522, $110,381, $101,086.

Source of gold and silver production in South Dakota in 1912.

Source.	Number of mines.	Tonnage.	Gold.		Silver.		Total value.
			Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine ozs.*		*Fine ozs.*		
Siliceous ore	20	1,901,459	381,034.88	$7,876,690	201,149	$123,707	$8,000,397
Lead ore	1	267	46.19	955	5,246	3,226	4,181
Total	21	1,901,726	381,081.07	7,877,645	206,395	126,933	8,004,578
Placer mines	19		663.95	13,725	65	40	13,765
Grand total	40	1,901,726	381,745.02	7,891,370	206,460	126,973	8,018,343

MINING INDUSTRY IN 1912.

CONDITIONS.

The Homestake mines and mills were operated continuously in 1912. With the exception of the Mogul property, the mill of which burned in March, all the other large properties of Lawrence County were operated continuously and several new producing properties were added to the list.

Placer mines in Custer, Lawrence, and Pennington counties yielded a slightly increased output. The most important production of placer gold came from the dredge at Mystic, Pennington County, which made a small increase over the output in 1911.

REDUCTION MILLS.

List of reduction mills in South Dakota in 1912, by counties.

Name.	Location.	Process.	Equipment.	Approximate maximum capacity per day.
				Short tons.
Custer County:				
Ruberta[a]	Custer	Amalgamation and cyanidation.	10 stamps, with cyanide annex, 2 percolation tanks.	30–40
Ruby[b]	do	Amalgamation and concentration.	Gates crusher, 10 stamps, 2 Frue vanners, 2 concentrating tables.	30
Lawrence County:				
Standard[b]	Cyanide	Cyanidation	1 Gates No. 4 crusher, 2 roller mills, 4 tanks.	100
Dakota[a]	Deadwood	do	30 stamps, wet-crushing; tanks	100
Golden Reward.[b c]	do	do	1 Gates crusher, 2 Chilean mills, 2 Huntington mills, 2 Akins, and 2 drag classifiers, 4 Dorr thickeners, 15 tanks (9 percolation, 6 agitation), Moore process.	200
Hidden Fortune.[a]	do	do		300
Imperial[a]	do	do	Blake crusher, Davis rolls, sampler, drier, 4 leaching tanks, dry-crushing.	125
Branch Mint[a]	Galena	do	120 stamps	400
Clover Leaf[a]	do	Amalgamation	60 stamps, plate amalgamation	240
Gilt Edge[a]	do	Concentration	1 Gates crusher, McFarlane rolls, Cone classifiers, 2 Monell slimers, 12 Monell concentrating tables.	150

[a] Idle, 1912.
[b] Active, 1912.
[c] For description, see Min. and Eng. World, June 7, 1913, pp. 1103–1104.

List of reduction mills in South Dakota in 1912, by counties—Continued.

Name.	Location.	Process.	Equipment.	Approximate maximum capacity per day.
Lawrence County—Continued.				*Short tons.*
Homestake [a] [b]	Lead	Amalgamation and cyanidation.	6 wet-crushing stamp mills, aggregating 1,000 stamps, 20 Gates crushers, 3 tube mills, 131 Cone and 2 Dorr classifiers, 1 Dorr thickener, 2 cyanide sand tanks, 1 cyanide slime plant, 25 percolation tanks, 28 Merrill filters.	4,200
Lucky Strike [c]	Maitland	Cyanidation	Stamps, tanks	150
Minnesota [c]	do	do	2 roughing rolls, 2 slow-speed Chilean mills, tanks.	150
North Homestake. [c]	do	do	40 stamps, Cone classifiers, 8 slime and 6 sand tanks, cyanidation by agitation and percolation.	150
Safe Investment. [c]	Novak	Cyanidation	40 stamps, concentrating tables, cyanide annex.	200
Hawkeye [c]	Pluma	Amalgamation and cyanidation.	2 old mills, 40 and 60 stamps	160
Mogul [b]	do	Cyanidation	Crushing, leaching sands, slimes to Moore process, 5 Dorr classifiers, 3 thickeners. Partly destroyed by fire in March, 1912; to rebuild as 200-ton plant at Terry.	400
Puritan [c]	do	Concentration and cyanidation.	20 stamps, 2 Dorr classifiers, Wilfley tables.	240
Imperial [c]	Portland	Cyanidation	30 stamps	100
Victoria [b] [d]	do	do	1(5-K) and 1(3-D) Gates crusher, Davis rolls, Allis-Chalmers rolls, trommels, 5 tanks, dry-crushing and leaching.	200
Lexington Hill. [c]	Spruce Gulch.	Amalgamation and cyanidation.	20 stamps, Barr amalgamator, Wilfley tables, leaching tanks.	100
Lundberg, Dorr and Wilson. [b]	Terry	Cyanidation	Chilean mill, No. 4 Gates crusher, 1 Dorr classifier, 1 Dorr thickener, 4 sand tanks (110 tons); 4 percolation, 1 agitation tank; Moore process.	100–130
New Reliance [b]	Trojan	do	1 Gates crusher, 30 stamps, 1 Dorr classifier, 4 Dorr thickeners, continuous counter-current decantation, 5 slime tanks, 1 Portland filter.	120
Trojan [b]	do	do	1 Gates No. 5–K crusher, 2 7-foot Chilean mills, 1 Dorr thickener, 2 Dorr duplex classifiers, 5 sand tanks (capacity, 925 tons dry sand), 5 percolation, 3 air agitation tanks, 1 stationary leaf-type filter. Capacity to be increased in 1913 to 400 tons.	150
Golden Crest [c]	Two Bit	do	40 stamps, 3 Dorr classifiers, 2 Dorr thickeners, tube mill; all-sliming, Moore filter process.	200
Bismarck [e] [f]	Yellow Creek (Flat Iron).	do	1 (5–K) and 2 (3–D) Gates crushers, 2 sets roller mills, Allis-Chalmers "A" 6 tanks. Dry crushing and leaching.	300
Wasp No. 2 [g] [b]	do	do	Steam shovel for stripping, 4 Gates crushers, 4 McFarlane rolls, 6 percolation tanks. Dry crushing and leaching.	520
Pennington County:				
Black Tom [c]	Castle Creek	Amalgamation	2 crushers, 10 stamps. Overhauled 1912.	20

[a] Clark, A. J., and Sharwood, W. J., Metallurgy of the Homestake ores: Bull. Inst. Min. and Met., No. 98, Nov. 14, 1912. Abstracted, Eng. and Min. Jour., Jan. 18, 1913, pp. 161–166, and Jan. 25, 1913, pp. 215–219; also Min. and Eng. World, Dec. 7, 1912, pp. 1035–1039, and Dec. 14, 1912, pp. 1090–1094, and Dec. 21, 1912, pp. 1142–1147, and Dec. 28, 1912, pp. 1189–1192; also Min. and Sci. Press, Jan. 11, 1913, p. 108; also Met. and Chem. Eng., Jan., 1913, p. 50.

[b] Active, 1912.

[c] Idle, 1912.

[d] For description, see Min. and Eng. World, Sept. 28, 1912, p. 571.

[e] Building, 1912.

[f] For description, see Min. and Sci. Press, Feb. 22, 1913, p. 320.

[g] For description, see Min. and Eng. World, Jan. 4, 1913, p. 11; also Min. and Eng. World, May 3, 1913, p. 849.

List of reduction mills in South Dakota in 1912, by counties—Continued.

Name.	Location.	Process.	Equipment.	Approximate maximum capacity per day.
Pennington County—Contd.				*Short tons.*
Hymalulu [a]	do	do	2 stamps; expect to add cyanide equipment in 1913.	15
Inca [b]	do	Amalgamation, concentration, cyanidation.	10 stamps, plates, Wilfley tables, tanks.	40
James G. Blaine, [a]	do	Amalgamation	1 Chilean mill	8
Canton [a]	Hill City	do	25-ton Chilean mill, plates, concentrating tables.	75
Golden Summit, [c]	do	do	1 Blake crusher, 10 stamps	30
Slipper [a]	do	do	5 stamps. To build cyanide plant	15–20
Bismarck [a]	Keystone	Amalgamation, concentration, and cyanidation.	Gates No. 3 crusher, 20 stamps, Isbell classifier, Wilfley No. 3 table, 3 Wilfley slimers; 6 tanks, agitation and percolation; 2 filters.	80–90
Otho [b]	Keystone	Amalgamation, concentration, and cyanidation.	3 crushers, 3 Chilean mills, 3 roller mills, 6 concentrating tables, agitation tanks.	100
Holy Terror [a]	do	do	1 20-stamp concentration mill, 1 15-stamp concentration mill, 1 cyanide mill.	80
Tykoon [a]	do	Amalgamation and concentration.	10 stamps, 1 classifier, 2 Wilfley and 1 slime concentration tables.	40
Forest City (Clara Belle). [c]	Oreville	Amalgamation and cyanidation.	10 stamps, cyanide tanks	50
Silver City [a]	Rapid Creek	Amalgamation	Huntington mill	20–25
Cochran [a]	Rochford	do	do	20
Gold King (Gordelia). [a]	do	do	1 crusher, 10 stamps, plates	40
Golden West [a]	do	do	Chilean mill, amalgamating plates	50
North Star [a]	do	do	25-ton Chilean mill, amalgamating plates.	75
Stanby [a]	do	do	60 stamps	80–240

[a] Idle, 1912. [b] Building, 1912. [c] Active, 1912.

Of the mills in South Dakota, 45 seemed worthy of note; of these, 2 are in Custer County, 25 in Lawrence County, and 18 in Pennington County. In Custer County, 1 mill was operated for a short time; in Lawrence County, 9 were operated (1 of these experimentally for a short time only), 15 were idle, and 1 was under construction; in Pennington County, 2 were operated for short periods only, 2 were under construction, 1 old mill was overhauled and operated experimentally, and 13 were idle.

The 8 important operating mills and the 1 under construction (but operating early in 1913) in Lawrence County are all cyanide mills, with the exception of the Homestake group of mills, which treat first by amalgamation, the sand and slimes being then treated by cyanidation. Of the remaining mills, 3 use coarse, dry crushing, and leaching, and 5 use wet crushing and separate treatment of sand and slime.[1]

[1] See McGraw, Herbert A., Cyanide practice in the Black Hills: Eng. and Min. Jour., Dec. 28, 1912, pp. 1221–1227; see also Parmelee, H. C., Cyanide practice in the Black Hills; Met. and Chem. Eng., July and Aug., 1913.

REVIEW BY COUNTIES.

CUSTER COUNTY.

Mine production of gold, silver, and copper in Custer County, S. Dak., from 1904 to 1912.

Year.	Number of mines producing.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1904	4	1,900	$6,491	121	.....	$6,560
1905	5	16	706	3	38	714
1906	2	16	687	3	.....	689
1907	1	33	332	3	.....	334
1908	2	470	1,533	4	.....	1,535
1909	1	400	1,311	21	.....	1,322
1910	.....	.....	.....	.....	.....	.....
1911	5	.....	309	4	.....	311
1912	5	75	1,187	3	.....	1,189
Increase (+) or decrease (−) for 1912	.....	+75	+878	−1	.....	+878

[a] Includes both deep and placer mines.

The mill on the Ruby group property, near Custer, was operated for a short time, and there was also a little development on other properties near Custer. Some sluicing operations near Custer resulted in a small but increased yield of placer gold.

LAWRENCE COUNTY.[1]

Mine production of gold, silver, copper, and lead in Lawrence County, S. Dak., from 1904 to 1912.

Year.	Number of mines producing.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	44	1,801,524	$7,346,986	161,216	.....	.....	$7,439,282
1905	19	1,826,177	6,955,690	182,597	.....	.....	7,065,979
1906	27	1,771,377	6,816,196	150,537	.....	22,719	6,918,351
1907	22	1,470,154	4,134,667	93,830	.....	.....	4,196,595
1908	17	1,927,844	7,650,523	248,686	.....	23,046	7,783,295
1909	17	1,699,260	6,561,628	191,044	3,977	1,512	6,661,553
1910	19	1,522,986	5,380,795	118,716	.....	14,136	5,445,523
1911	16	1,940,719	7,408,356	203,350	.....	64,311	7,519,025
1912	19	1,901,310	7,875,401	206,356	.....	22,845	8,003,338
Increase (+) or decrease (−) for 1912	+3	−39,409	+467,045	+3,006	.....	−41,466	+484,313

[a] Includes both placer and deep mines.

All the large mines of the State are in this county. Of the State total of $8,019,371, Lawrence County produced $8,003,338, of which $7,875,401 was for gold. The silver yield was 206,356 ounces, and the lead output was 22,845 pounds. Comparing the yields for 1911 and 1912 we find that in Lawrence County in 1912 there was an output of 380,972.52 fine ounces of gold, as against 358,379.25 fine ounces

[1] Irving, J. D., Ore deposits of the northern Black Hills: Bull. U. S. Geol. Survey No. 225, 1904, pp. 123–140. Irving, J. D., and Emmons, S. F., Economic resources of northern Black Hills: Prof. Paper U. S. Geol. Survey No. 26, 1904, pp. 53–212.

in 1911, an increase for 1912 of 22,593.27 fine ounces, or $467,045 at the full value of $20.67+ per ounce; the silver production, at $0.53 an ounce in 1911, was $107,775, and at $0.615 an ounce in 1912 was $126,909, an increased value in 1912 of $19,134; the lead yield in 1911, at $0.045 per pound, was $2,894, and in 1912, at $0.045 per pound, was $1,028, a decrease for 1912 of $1,866; a total increase in valuation for the 1912 output of $484,313.

During 1912 there were 1,901,310 short tons of ore treated (practically all siliceous) from 16 deep mines, with an average value per ton of $4.14 in gold and of $0.067 in silver, as compared with 12 mines in 1911, with an output of 1,940,719 short tons and an average value of $3.82 in gold and $0.06 in silver, and with 15 mines in 1910, with an output of 1,522,896 short tons and an average value per ton of $3.53 in gold and $0.042 in silver. In 1912 there were treated in the mills of the county 1,893,420 tons, which yielded to the amalgamating plates and cyanide treatment $7,731,367 in gold and 179,291 fine ounces of silver, valued at $110,264, with a total value of $7,841,631, at an average value per ton in gold of $4.08 and in gold and silver at $4.14. To smelters outside the State were sent 7,890 tons, containing $142,839 in gold and 27,060 fine ounces of silver, with a total value of $159,481, at an average value per ton of $18.10 in gold and $20.21 in gold and silver. Smelters also recovered 22,845 pounds of lead from ores from this county.

The output of placer gold from three placers, all near Tinton, Rawlings district, showed a small increase.

The Homestake mine,[1] which annually yields the bulk of the gold bullion from this State, was operated continuously throughout the year, with a small increase in tonnage but an appreciable increase in average value per ton. The Homestake Co.'s public report[2] for the calendar year 1912 shows: Ore treated, 1,528,923 tons; production, $6,600,953; value per ton, $4.31738; dividends, $1,310,400; hydroelectric plant expenditure, $237,368; purchase of property expenditure, $151,567; mine, 1,000 stamps, tailing and slime plants, and hydroelectric plant valuation, $21,840,000.

The Spearfish hydroelectric plant is completed. There are broken in the mine, 2,030,217 tons of ore.

In the Bald Mountain area and the Portland district the mines were operated steadily. The tonnage of oxidized ore from the Golden Reward group milled at the company's plant near Deadwood was equal to the 1911 yield, but an increased tonnage of sulphide ore was shipped to smelter. A 75-ton Wedge roaster was added at the mine for the preliminary treatment of the ores of the Astoria mine before cyanidation. The plant will also be used for experimentation on the "blue" (or unoxidized) ores of the Bald Mountain district.[3] The Mogul mine was operated all the year, but after the burning of the Mogul mill, at Pluma, in March, the ore was sent to the Lundberg, Dorr & Wilson custom mill at Terraville, and the production for the year showed a decrease. The Lundberg, Dorr & Wilson mill was

[1] Clark, A. J., and Sharwood, W. J., Metallurgy of the Homestake ores: Bull. Inst. Min. and Met. No. 98, Nov. 14, 1912. Abstracted, Eng. and Min. Jour., Jan. 18, 1913, pp. 161–166, and Jan. 25, 1913, pp. 215–219; also Min. and Eng. World, Dec. 7, 1912, pp. 1035–1039, Dec. 14, 1912, pp. 1090–1094, Dec. 21, 1912, pp. 1142–1147, and Dec. 28, 1912, pp. 1189–1192; also Min. and Sci. Press, Jan. 11, 1913, p. 108; also Met. and Chem. Eng., Jan. 1913, p. 50.

[2] Min. and Sci. Press, Mar. 15, 1913, p. 433; also Eng. and Min. Jour., Mar. 15, 1913, p. 584.

[3] Simmons, Jesse, Min. and Sci. Press, Jan. 4, 1913, p. 80, on the subject of roasting these ores. See also Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, p. 535.

operated also on ores from the company's Buxton and Bonanza properties and from Bertschy's lease on the Midget and Dakota mines. The Trojan mill was operated continuously in 1912, as against five months in 1911, with a resulting increased tonnage treated. The New Reliance mine and mill were operated seven months. The Deadwood-Standard mine and mill were operated for a time. The Victoria mine and mill were also operated for a short time. A small shipment was made from the Gold Bottle mine to the Omaha smelter.

In the Bear Butte (or Galena) district, lead-silver ore was shipped from the Richmond-Sitting Bull property. Development work was continued on the Gilt Edge mine and the new 250-ton concentration mill was completed. Development work was continued on the Bristol mine.

Several cars of ore, carrying appreciable quantities of gold and silver, were shipped from the Monarch mine, situated between Two Bit and Whitewood gulches.

In the Yellow Creek area the dry-crushing cyanide plant of the Wasp No. 2 Mining Co. was operated continuously. The ore is mined by the open-cut system, a steam shovel being used for stripping. The public annual report of the company shows that during 1912 there were mined 158,840 tons of ore, which yielded $308,175, an average of $1.94 per ton. Mining cost $0.567 per ton; milling, $0.627 per ton; general expenses, $0.04 per ton; a total of $1.234 per ton.[1] The Bismarck Consolidated Mines Co. completed its 300-ton cyanide mill.

PENNINGTON COUNTY.

Mine production of gold, silver, and copper in Pennington County, S. Dak., from 1904 to 1912.

Year.	Number of mines producing.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1904	16	1,511	$10,500	274	.....	$10,657
1905	8	11,218	33,096	149	.....	33,186
1906	6	9,281	24,586	335	.....	24,810
1907	7	969	3,190	62	.....	3,231
1908	8	1,235	5,320	72	.....	5,358
1909	13	4,481	14,897	3,208	114,408	31,438
1910	7	943	21,462	84	.....	21,508
1911	16	5,408	31,209	401	.....	31,422
1912	16	341	14,782	101	.....	14,844
Increase (+) or decrease (−) for 1912	.....	−5,067	−16,427	−300	.....	−16,578

[a] Includes both deep and placer mines.

The output of placer gold and silver in Pennington County in 1912 was $11,778, as against $10,713 in 1911; but the value of gold and silver from deep mines was only $3,066, as against $20,709 in 1911. There were 12 producing placer mines and 4 deep mines in 1912.

Near Mystic, on Castle Creek, the Castle Creek Hydraulic Gold Mining Co. operated its dredge from June into September. Some development work was done on the Black Tom and on the James G. Blaine mines, and ore was mined and stored at the Inca Mine, awaiting the completion of a 10-stamp amalgamation and cyanide mill.

[1] Min. and Sci. Press, Mar. 15, 1913, p. 33.

At Hill City the Golden Summit mill was operated for a time on ore from the Golden Summit mine and on a test lot from the Dolcode mine. Assessment and development work was done on the Antlers mine, the Hill City Mining & Development Co.'s property, and on the Slipper mine.

In the Hornblende district, near Rochford, considerable development work was done on the Gold King mine.

At Keystone a small quantity of bullion was shipped from the Bismarck mill. A little gold was recovered from the Gold Bug placer. The Mint-Gold Placer Co. reported eight months' work in exploration and testing of placer ground to determine the feasibility of operation by hydraulicking. The Otho Development & Power Co. reports considerable development work and progress in the construction of a 100-ton amalgamation and concentration mill.

At Oreville the 10-stamp amalgamation mill on the Clara Belle property was operated for a short time.

On Rapid Creek, near Pactola, several small sluice and drift mines were operated.

At Rockerville a small quantity of placer gold was recovered by sluicing.

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TEXAS.[1]

By Charles W. Henderson.

PRODUCTION.

The following table shows the production of gold, silver, copper, lead, and zinc in Texas in 1911 and 1912:

Production of gold, silver, copper, lead, and zinc in Texas in 1911 and 1912.

Year.	Gold.		Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		*Pounds.*		*Pounds.*		
1911	1.02	$21	424,394	$224,929	.....	.....	122,800	$5,526	.....	.....	$230,476
1912	3.05	63	406,067	249,731	721	$119	65,311	2,939	238,000	$16,422	269,274
Increase (+) or decrease (−).	+2.03	+42	−18,327	+24,802	+721	+119	−57,489	−2,587	+238,000	+16,422	+38,798

[1] The publications of the United States Geological Survey mentioned in the following list may be obtained free by applying to the Director, United States Geological Survey, Washington, D. C., except those to which a price is affixed; they may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

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——— The production of silver in the United States in 1904: Bull. U. S. Geol. Survey No. 260, 1905, pp. 39–44.

——— A geological analysis of the silver production of the United States in 1906: Bull. U. S. Geol. Survey No. 340, 1908, pp. 23–35.

——— Resources of the United States in gold, silver, copper, lead, and zinc: Bull. U. S. Geol. Survey No. 394, 1909, pp. 114–156.

The total value of the production of gold, silver, copper, lead, and zinc in Texas in 1912 was $269,274, an increase of $38,798 over the value for 1911. The output of silver, which represents 93 per cent of the value of the State yield, was 406,067 fine ounces, valued at $249,731, a decrease of 18,327 ounces in quantity but an increase in value of $24,802, due to increase in average price per ounce from $0.53 in 1911 to $0.615 in 1912. The yield of lead was 65,311 pounds, as compared with 122,800 pounds in 1911. The yield of gold and copper was nominal. The output of zinc was 238,000 pounds. The greater part of the output of the State of these metals was from the Shafter district, Presidio County, except the zinc yield, which was from the Sierra Blanca district, El Paso County.

TOTAL PRODUCTION OF TEXAS.

The following table gives the total production in Texas of gold, silver, copper, lead, and zinc from 1885 to 1912, inclusive:

Footnote—Continued.

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Production of gold, silver, copper, lead, and zinc in Texas, 1885–1912.

Year.	Gold.	Silver.		Copper.		Lead.		Zinc.		Total value (commercial).
		Fine ounces.	Commercial value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	
1885 [a]		[b e] 169,342	[c] $181,196							$181,196
1886		[b e] 191,873	[d] 189,954							189,954
1887		[b f] 235,999	231,279	(g)						231,279
1888		[h] 380,068	357,264							357,264
1889	[i] $6,828	[i] 323,438	304,032							310,860
1890	[j] 78	[j] 370,000	388,500	(j)						388,578
1891		[k] 375,000	371,250	[l] 42,000	$5,376	[l] 7,385	$318			376,944
1892		[m] 328,100	285,447							285,447
1893	[o] 2,662	[n] 349,400	272,532							275,194
1894	[no] 4,320	[n] 429,314	270,468							274,788
1895		[n] 450,000	292,500							292,500
1896	[n] 8,000	[n] 525,400	357,272			(y)				365,272
1897	[n] 7,400	[n] 404,700	242,820			(y)				250,220
1898	[n] 300	[n] 472,900	279,011			(y)				279,311
1899	[n] 6,900	[n] 520,000	312,000			(y)				318,960
1900	[n] 1,100	[n] 477,400	295,988							297,088
1901	[n] 600	[n] 472,400	283,440			(y)				284,040
1902		[n] 446,200	236,486			(y)				236,486
1903		[n] 454,400	245,376			(y)				245,376
1904	[pq] 186	[pq] 385,576	223,634			(y)				223,820
1905	[pr] 248	[pr] 387,506	236,379							236,627
1906	[ps] 1,592	[ps] 301,772	205,205			[p] 49,030	2,795	[z] 16,000	$976	210,568
1907	[pt] 9	[pt] 303,688	200,434			[p] 23,947	1,269	[p] 44,000	2,596	204,308
1908	(pu)	[pu] 444,336	235,498	[p] 28,364	3,744	[p] 65,833	2,765	[p] 35,957	1,690	243,697
1909	[pv] 314	[pv] 374,444	194,711	[p] 3,862	502	[p] 91,140	3,919			199,446
1910	[pw] 423	[pw] 380,322	205,374	[p] 3,157	401	[p] 65,068	2,863			209,061
1911	[px] 21	[px] 424,394	224,929			[p] 122,800	5,526			230,476
1912	[p] 63	[p] 406,067	249,731	[p] 721	119	[p] 65,311	2,939	238,000	16,422	269,274
Total	41,044	10,784,039	7,372,710	78,104	10,142	490,514	22,394	333,957	21,684	7,467,974

[a] Mineral Resources U. S. for 1908, 1909, p. 541, and for 1910, pt. I, 1911, p. 572. Report from Presidio Mining Co. says "mine operated continuously since 1884." Company report (1908) also says "mill was started Dec. 25, 1885, and operated steadily to date."

[b] Report of Director of the Mint for 1887, p. 238, being the report of Francis N. Holbrook, agent for the mint.

[c] Mineral Resources U. S. for 1885, p. 201, gives $90,000 for combined production of Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming.

[d] Mineral Resources U. S. for 1886, p. 105, gives $205,000 for combined production of Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming.

[e] Phillips, W. B., The Mineral Resources of Texas: Bull. Texas Dept. of Agri. No. 14, July–August, 1910, p. 22; gives 155,039 fine ounces, valued at $154,263, for 1882–1886.

[f] Rept. Director of the Mint estimate for 1887 is 193,364 ounces, valued at $250,000; Mineral Resources for 1887, the same; Phillips, op. cit., gives 193,798 ounces.

[g] Mint agent says (pp. 237–238): "Ores of the Carrizo district (near Van Horn, Culberson County) * * * average about 54 ounces silver per ton and 6 to 20 per cent copper. Mines actually worked and shipping ore—Hazel, Sancho Panza, Llewellyn, Gracie."

[h] Holbrook, Rept. Director of Mint for 1888, pp. 22, 155. Director of Mint gives 232,031 ounces (p. 22), but gives the same (232,031 ounces) for 1889, p. 21.

[i] Mineral Resources U. S. for 1889–1890, p. 49, being Eleventh Census figures. Director of the Mint for 1889 gives 232,031 ounces; mint agent gives 310,007 ounces; Phillips, 324,165 ounces.

[j] Yale, Chas. G., mint agent, Rept. Director of the Mint for 1890, pp. 20, 180, gives: Presidio mine, 5,596 tons, 163,952 ounces silver; Cibolo Creek, 4,618 tons, 119,071 ounces silver; Hazel, $83,000 silver, some copper. Chaouti (Chinati?) mine (at Shafter) shipped 22,750 pounds of ore, averaging 26 ounces silver, ⅓ ounce gold, 31 per cent lead. Mentions Bonanza mine (Sierra Blanca district, El Paso County). Rept. Director of the Mint, p. 21, and Mineral Resources U. S. for 1889–1890 give 300,000 ounces; Phillips, 300,690 ounces.

[k] Director of the Mint, Mineral Resources U. S., and Phillips for 1891.

[l] Mint agent, Rept. Director of the Mint, p. 220, gives 357,370 ounces silver, 42,000 pounds of copper (from 600 tons of ore from Hazel mine) and 7,358 pounds of lead (from 10.8 tons of ore from Bonanza mine).

[m] Mineral Resources U. S. for 1893, p. 50, also Rept. Director of the Mint for 1893, p. 19, and subsequent reports. Mineral Resources U. S. for 1892 and mint for 1892 give 310,000 ounces.

[n] Mineral Resources U. S., being estimate by Director of the Mint. Mint agent's figures for these years correspond closely with director's figures.

[o] Agent's figures, Director of the Mint.

[p] Mineral Resources U. S., U. S. Geol. Survey. Collected from the mines.

[q] Director of the Mint gives $2,300 gold and 469,600 ounces of silver.

[r] Director of the Mint gives $1,900 gold and 417,200 ounces of silver.

[s] Director of the Mint gives $3,400 gold and 277,400 ounces of silver.

[t] Director of the Mint gives $1,000 gold and 305,300 ounces of silver.

[u] Director of the Mint gives $500 gold and 447,000 ounces of silver.

[v] Director of the Mint gives $400 gold and 408,100 ounces of silver.

[w] Director of the Mint gives $400 gold and 364,400 ounces of silver.

[x] Director of the Mint gives $3,900 gold and 444,200 ounces of silver.

[y] Included with Washington, Oregon, Alaska, and South Dakota for 1896, 1897, 1898, 1899, 1901. Included with Oregon, Alaska, and South Dakota for 1902, 1903, 1904.

[z] Smelter figures.

REDUCTION MILLS.

List of reduction mills in Texas in 1912.

CULBERSON COUNTY.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
				Short tons.
Hazel [a]	Van Horn (15 miles northwest).	Dry concentration.	Blake crusher, 2 sets, 14 by 12 rolls; 12 Sutton, Steele & Steele classifiers; 5 Sutton, Steele & Steele concentration tables; Sutton, Steele & Steele dielectric separator.	100
EL PASO COUNTY.				
Bonanza [b]	Sierra Blanca (9½ miles west).	Dry concentration.	Sutton, Steele & Steele tables.	50
LLANO COUNTY.				
Heath [b] [c]	Llano (5 miles east).	Amalgamation and concentration.	9 by 12 Dodge crusher, 10-foot Lane slow-speed mill, amalgamating plates; Barr amalgamators; hydraulic classifier; 2 Wilfley tables; Frenier sand pump.	50
PRESIDIO COUNTY.				
Presidio [d]	Shafter	Pan-amalgamation (modernized patio process) and concentration.[e]	Blake crusher, 15 stamps (1,050 pounds); 2 Wilfley tables. Reconstructed 1913; operating Apr. 30, 1913, as all-sliming, continuous agitation, and filtration cyanide plant, capacity 100 tons.	70

[a] Under construction 1912.
[b] Idle 1912.
[c] For description, see McLaren, Alex., Salt Lake Min. Rev., vol. 14, No. 3, May 15, 1912, p. 13.
[d] Active 1912.
[e] For description of process, see Phillips, W. B., Eng. and Min. Jour., Dec. 31, 1910, p. 1303.

REVIEW BY COUNTIES.

BREWSTER COUNTY.

There was a little prospecting near Alpine in 1912. Surface sampling shows silver, lead, and a little gold. In this district are the Caruthers prospect and the Bird mines. From the latter in the past some silver-bearing galena has been shipped to the El Paso smelter.[1]

BURNET COUNTY.

Some development work was done in 1912 near Burnet, it being reported that copper, lead, and zinc minerals have been found in the district.[2]

[1] Phillips, W. B., Lead ore in Burnet County, Tex.: Eng. and Min. Jour., vol. 77, 1904, p. 364.
[2] See also Phillips, W. B., op. cit., p. 364.

CULBERSON COUNTY.

The mining districts of this county were included in El Paso County before 1911. A shipment of ore, chiefly valuable for its copper content but also containing a little gold and silver, was made from Van Horn. At the Hazel mine, northwest of Van Horn, in pre-Cambrian sandstone,[1] a 100-ton dry concentration mill was being built during 1912–13. The equipment installed includes the Sutton, Steele & Steele classifiers and tables, with dielectric separator for the removal of barite. This mine in the past has been an important producer of silver-copper ores.[2]

EL PASO COUNTY.

In the Sierra Blanca district, the Tama mine was operated for a time and two cars of siliceous gold-silver ore were taken out. From the Bonanza [3] mine a car of silver-lead ore was shipped to El Paso, and several cars of zinc sulphide were shipped to Neodesha, Kans. The Sutton, Steele & Steele dry concentration mill on this property was not operated.

KNOX COUNTY.

A little development work was done on Pyron copper prospect, near Truscott, in the blue clays of the Permian [4] beds.

LLANO COUNTY.[5]

The Llano Gold & Rare Metal Mining Co. completed at the Heath [6] mine, near Llano, a 50-ton mill and operated it experimentally, closing down, it is reported, to await the results of experiments in the separation of platinum from the concentrates.

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[1] Richardson, G. B., Reconnaissance of trans-Pecos, Texas: Bull. Univ. Texas Mineral Survey No. 9, 1904, pp. 24–25.

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[4] Cummins, W. F., Notes on the geology of Northwest Texas: Fourth Ann. Rept. Geol. Survey Texas, 1893, pp. 232–238.
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[5] Auriferous and argentiferous copper ore in Llano County. Trans. Am. Inst. Min. Eng., vol. 5, 1876–7, p. 16.
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PRESIDIO COUNTY.

Shafter district.[1]—The greater part of the total silver output of Texas has come from this district and chiefly from the Presidio mine, which has been operated steadily since 1884. The mine is opened by several shafts, the two principal ones being 400 and 700 feet deep, and by 18 miles of underground workings. The ore bodies are for the most part confined to the Cibolo limestone of the Carboniferous.[2] The ore, which is chiefly silver chloride (horn silver) with which are associated more or less isolated patches of silver-bearing galena, is crushed by stamps, 15 in number; this is followed by pan amalgamation, with sulphate of copper, salt, and quicksilver. For several years some of the lead in the ore has been recovered by concentrating the tailings over Wilfley tables. During the spring of 1913 the 70-ton pan-amalgamation mill (built originally in 1884) was reconstructed and after April 30, 1913, was operated as a cyanide plant, using the all-sliming process and continuous agitation and filtration, with an increase in capacity to 100 tons.

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UTAH.

By V. C. Heikes.

PRODUCTION.

The production of gold, silver, copper, lead, and zinc in Utah from 7,770,270 tons of ore and a small placer output was valued at $42,922,302, an increase of $6,084,845, as compared with 7,268,530 tons of ore in quantity and $36,837,457 in value in 1911 from deep mines and a nominal placer yield. There were 207 properties, 9 of which were placers, producing ore and bullion, as against 200 lode producers and 8 placers in 1911. Over one-half of the total value in 1912 represented the copper production, which was valued at $22,655,735, an increase of $4,285,632 as compared with the production of 1911. Increases in total value were made in all the other metals except gold, the yield of which was $431,147 less than in 1911. Salt Lake County had the greatest total value for its metal output, which increased from $22,561,615 in 1911 to $24,684,132 in 1912. This was chiefly due to the higher price of copper in 1912, as all the metals produced in the county decreased in quantity as a result of the labor strike. Concentrates recovered from ores at milling plants in 1912 contained 21.4 per cent of the gold, against about 22 per cent in 1911; 20.1 per cent of the silver, against 19.8 per cent; 76 per cent of the copper, against 73 per cent; 33 per cent of the lead, against 34 per cent; and 63 per cent of the zinc, against 74 per cent in 1911. In 1912 the concentrates were valued at $22,781,896, or an average value of $59.74 per ton, as against a total value in 1911 of $18,633,465 and an average value of $52.14 per ton. Crude ores shipped directly to smelters yielded 67.3 per cent of the gold in 1912, as against 63.8 per cent in 1911; 78 per cent of the silver, as against 79 per cent; 23 per cent of the copper, as against 26.3 per cent; 63 per cent of the lead, as against 65.6 per cent; and 37 per cent of the zinc, as against 26.2 per cent in 1911. In 1912 the total value of the crude ore shipped to smelters was $19,188,571, or an average value of $18.51 per ton, as against a total value in 1911 of $17,364,933, or an average value of $15.74 per ton. At gold and silver mills, 10.3 per cent of the gold and 0.46 per cent of the silver was recovered from ores treated principally by the cyanide process, valued at $479,724, or an average value of $2.80 per ton. The placer production of gold increased slightly, and was valued at $5,680, as against $5,634

reported in 1911. Statistics of the annual production from 1904 to 1912, inclusive, are shown in the following table:

Quantity of ore sold or treated in Utah in 1904–1912, number of mines producing, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904.....	112	1,716,947	$4,189,292	12,949,446	46,417,234	116,479,764	73,439	$21,989,415
1905.....	121	2,181,061	5,140,920	11,036,471	57,298,054	103,882,009	3,330,327	25,824,387
1906.....	133	2,348,819	5,218,386	11,550,634	56,593,576	125,342,836	6,474,615	31,419,365
1907.....	179	2 669,696	5,121,646	10,990,076	64,256,884	115,938,037	5,452,916	31,692,911
1908.....	179	3,658,957	3,701,387	8,451,338	86,843,812	88,777,498	1,460,554	23,441,280
1909.....	179	5,122,589	4,206,548	11,717,172	108,947,811	148,486,463	9,860,778	31,380,092
1910.....	183	6,389,398	4,032,085	10,466,971	127,597,072	123,324,635	16,367,104	32,199,184
1911.....	208	7,268,530	4,696,998	12,473,787	146,960,827	136,496,750	17,840,261	36,837,457
1912.....	207	7,770,270	4,265,851	13,835,903	137,307,485	140,311,135	17,067,177	42,922,302
Increase (+) or decrease (−) in 1912.....		+501,740	−431,147	+1,362,116	−9,653,342	+3,814,385	−773,084	+6,084,845

[a] Includes a small placer production.

ORE PRODUCTION IN 1912.

The total quantity of ore sold or treated in Utah in 1912 was 7,770,270 short tons, valued at $42,916,594, an increase of 501,740 tons in quantity and of $6,084,788 in value when compared with the production of 1911. The average total recoverable value per ton was $5.52 in 1912, against $5.07 in 1911, and the gold and silver value rose from $1.55 to $1.64 per ton. There was an unusually large quantity of old slag and old tailings smelted. These were produced in the early years of mine exploitation near Stockton, in the Rush Valley district, and at Frisco, in Beaver County. Many old waste dumps at the mines were found of sufficient value to be shipped to the smelters. This was the case at several properties in the Tintic district and in other districts to a more or less extent. The output of dry or siliceous ores decreased from 464,229 tons in 1911 to 369,736 tons in 1912. Under this classification is included 164,508 tons of low-grade siliceous gold ores, averaging per ton $2.58 in gold and 0.0014 ounce of silver. Gold and silver mixed ores, dry or siliceous in character, aggregated 115,941 tons, and averaged $6.24 in gold, 11.06 ounces of silver, 27.2 pounds of copper, and 2.5 pounds of lead. The siliceous silver ores in 1912 aggregated 81,234 tons, mined by 18 producers, averaging per ton $3.91 in gold, 27.06 ounces of silver, 2.5 pounds of copper, and 0.019 pound of lead, as against 92,520 tons, produced by the same number of producers in 1911, averaging $4.44 in gold, 21.21 ounces of silver, 10.6 pounds of copper, and 11.7 pounds of lead. These ores of silver were produced principally in the Tintic district, and smaller quantities came from the Ophir, Rush Valley, and Park City districts. Oxidized iron-manganese ores, carrying

very small quantities of gold and silver, were produced in the Tintic district and near Marysvale, in Piute County, but the yield decreased from 40,276 tons in 1911 to 8,053 tons in 1912. This decrease in iron-ore flux was largely due to the use of old lead furnace slags as flux at the smelters. The slags averaged about 26 per cent of iron, the same in silica, and carried about 40 cents in gold and 5 ounces of silver per ton, and 6 per cent of lead and 0.76 per cent of copper. The old slag dump of the Chicago smelter, operated over 35 years ago, near Stockton, was all shipped to the smelters near Salt Lake in 1912. The copper ore mined by 42 operators aggregated 6,670,845 tons, and contained 33 cents in gold, 0.38 ounce of silver, 19.14 pounds of copper, and $3.73 per ton in value. In 1912 over 90 per cent of the copper ore, or 6,100,533 tons, was from low-grade disseminated deposits at Bingham and Newhouse. All this "porphyry" copper ore was concentrated and the concentrates were smelted. The remainder of the copper ore mined was directly smelted and consisted of 425,083 tons of sulphides of copper and iron, averaging $1.93 in gold, 1.82 ounces of silver, and 33 pounds of copper. The oxidized copper ores, including ores with an excess of iron, which were shipped to smelters, aggregated 147,271 tons and averaged $3.93 in gold, 9.6 ounces of silver, and 74.34 pounds of copper. The output of lead ores of smelting grade decreased from 261,333 tons in 1911 to 252,888 tons in 1912. In this kind of ore smelted, the sulphides predominated and aggregated 133,693 tons, averaging per ton $1.10 in gold, 14.31 ounces of silver, 14.92 pounds of copper, and 369.1 pounds of lead. The oxidized ores of lead, largely carbonates, and some oxidized iron ores, aggregated 119,195 tons, and averaged per ton $2.27 in gold, 26.51 ounces of silver, 8.92 pounds of copper, and 282.97 pounds of lead. Production of zinc ores of shipping grade increased from 5,753 tons mined in 1911 to 9,422 tons mined in 1912. The mixed carbonate and siliceous zinc ores were produced in the largest quantities, aggregating 7,360 tons, from which was recovered an average of 20 cents in gold, 1.67 ounces of silver, 56 pounds of lead, and 600.96 pounds of spelter per ton. The zinc sulphide ores aggregated 2,031 tons, yielding 1.15 ounces of silver, 104.4 pounds of lead, and 577.72 pounds of spelter per ton. Production of copper-lead ores increased from 3,553 tons in 1911 to 5,102 tons in 1912. The oxidized or carbonate copper-lead ores shipped directly predominated and aggregated 3,154 tons, averaging $1.03 in gold, 41.49 ounces of silver, 82.55 pounds of copper, and 253.31 pounds of lead. The sulphide copper-lead ores aggregated 233 tons, and averaged per ton 84 cents in gold, 33.72 ounces of silver, 139.33 pounds of copper, and 228.59 pounds of lead. Lead-zinc ore mined in 1911 aggregated 280,817 tons, against 216,764 tons mined in 1912. All of the lead-zinc ore was milled, producing concentrate, with the exception of 1,402 tons of carbonate ore, which was reported to have been used in the manufacture of zinc pigment. The recovery assay of the ore was 143.68 pounds of lead and 538.10 pounds of zinc figured as spelter.

Output of ore and production of metals in Utah in 1912, by kinds of ore.

Source of production.	Number of producers.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
			Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	9	.....	$5,680	46	.....	.....	.....
Siliceous	45	361,683	1,469,640	3,484,296	3,373,103	1,809,989	.....
Iron or manganese	3	8,053	3,088	2,266	.....	.....	.....
Copper	42	6,670,845	2,185,427	2,542,381	127,712,169	2,194,024	.....
Lead	124	498,401	502,548	6,212,219	4,482,998	106,978,033	10,608
Zinc	14	9,422	2,112	14,941	660	626,503	5,599,262
Copper-lead	17	5,102	3,547	154,091	355,779	941,532	.....
Lead-zinc	17	216,764	93,809	1,425,663	1,382,776	27,761,054	11,457,307
Total	.....	7,770,270	4,265,851	13,835,903	137,307,485	140,311,135	17,067,177

Subdivision of tonnage, by kinds, of ore sold or treated from Utah in 1912, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	28	179,932	27,404	2,062	142	.....	209,568
Boxelder	430	5,656	269	.....	.....	.....	6,355
Grand	1	.....	.....	.....	.....	.....	1
Iron	106	.....	5	.....	.....	.....	111
Juab	189,806	128,871	68,174	1,259	472	.....	388,582
Millard	.....	21	.....	.....	.....	.....	21
Morgan	.....	.....	134	.....	.....	.....	134
Piute	1,130	34	171	.....	.....	.....	1,335
Salt Lake	6,690	6,356,312	142,857	.....	3,823	66,865	6,576,547
Sevier	.....	.....	120	.....	.....	.....	120
Summit	2,701	.....	125,743	.....	.....	89,546	217,990
Tooele	164,026	19	101,811	682	665	1,402	268,605
Utah	4,800	.....	27,983	5,419	.....	.....	38,202
Wasatch	.....	.....	3,730	.....	.....	58,951	62,681
Washington	18	.....	.....	.....	.....	.....	18
Total	369,736	6,670,845	498,401	9,422	5,102	216,764	7,770,270
Value per ton in gold and silver	$9.78	$0.56	$8.67	$1.20	$19.27	$4.48	$1.64

GOLD.

The production of gold was valued at $4,265,851, a decrease of $431,147, or 10 per cent, compared with 1911. The largest producer of gold was Juab County, which yielded $1,804,842, against $1,500,359 in 1911. The Tintic district, which is partly in Juab County and partly in Utah County, produced $1,900,731, or 44 per cent of the total output. The Bingham district, in Salt Lake County, ranked first in gold output in 1911, but was second in 1912, when it produced $1,785,532, or about 42 per cent of the total. Tooele County is credited with $450,632 in 1912 and $584,917 in 1911. This county has for 23 years been a large producer of gold from the Consolidated Mercur mine, in the Camp Floyd district, but at the end of 1912 this mine was on the verge of closing, having about exhausted its ore bodies. Placer gold was produced in Uinta, Garfield, San Juan, and Grand counties, and amounted in value to $5,680, against $5,634 in 1911. Milling of the ores in 1912 by amalgamation was carried on in Boxelder and Iron counties and by cyanidation in Salt Lake and Tooele

counties. The gold bullion produced from these two processes in Utah contained $440,076 in gold from the treatment of 171,117 tons of ore and 250 tons of old tailings, from which the average recovery was $2.57 per ton. The gold extracted by amalgamation from ore and tailings averaged $5.20 per ton treated, as against $3.23 per ton treated in 1911, and by cyanidation $2.56 per ton treated, as against $2.29 in 1911. There were 3 mills in the Camp Floyd district treating ore by the cyanide process. The gold production from this source and for the State of Utah will be greatly diminished in 1913 by the closing of the Mercur mine. Gold that was contained in the copper, lead, zinc, and copper-lead concentrates amounted to 44,055.07 ounces, against 50,225.12 ounces in 1911. The copper concentrates contained the largest quantity, or 36,882.93 ounces, against 42,589.23 ounces in 1911; the lead concentrate, 6,917.15 ounces, against 7,568.01 ounces in 1911; zinc concentrates, 253.92 ounces, against 64.12 ounces in 1911; and copper-lead concentrates, 1.07 ounces, against 3.76 ounces in 1911.

Source of gold production of Utah, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper lead ore.	Lead zinc ore.	Total.
Beaver	.....	77.01	758.13	813.43	0.14	1.60	.....	1,650.31
Boxelder	.....	123.26	.38	10.07	.....	.....	.....	133.71
Garfield	56.50	.....	.....	.....	.....	.....	.....	56.50
Grand	3.82	.....	.....	.....	.....	.....	.....	3.82
Iron	.....	20.08	.....	.....	.....	.....	.....	20.08
Juab	.....	48,603.86	29,071.59	9,572.59	3.38	57.81	.....	87,309.23
Millard	.....	.....	9.00	.....	.....	.....	.....	9.00
Piute	.....	149.14	7.93	10.21	.....	.....	.....	167.28
Salt Lake	.....	1,138.46	75,873.00	5,956.99	.....	102.07	3,459.29	86,529.81
San Juan	30.00	.....	.....	.....	.....	.....	.....	30.00
Summit	.....	62.16	.....	2,353.15	.....	.....	560.87	2,976.18
Tooele	.....	20,419.77	.....	1,369.45	.....	10.10	.....	21,799.32
Uinta	184.45	.....	.....	.....	.....	.....	.....	184.45
Utah	.....	640.09	.....	4,054.59	98.65	.....	.....	4,793.33
Wasatch	.....	.....	.....	170.28	.....	.....	517.85	688.13
Washington	.....	9.39	.....	.....	.....	.....	.....	9.39
Total	274.77	71,243.22	105,720.03	24,310.76	102.17	171.58	4,538.01	206,360.54

SILVER.

The silver production of Utah in 1912 was 13,835,903 fine ounces, valued at $8,509,080, and showed an increase of 1,362,116 ounces, or 10 per cent in quantity, and of $1,897,973 in value. Juab County produced 6,638,425 ounces in 1912, against 4,673,698 ounces in 1911, and Utah County 531,478 ounces in 1912, against 934,768 ounces in 1911. The Tintic district, covering parts of these two counties, increased its output from 5,514,702 ounces in 1911 to 7,073,104 ounces in 1912. Salt Lake County produced 2,218,822 ounces in 1912, against 2,947,481 ounces in 1911. Of the Salt Lake County yield, the West Mountain or Bingham district contributed 2,028,496 ounces in 1912 and 2,786,810 ounces in 1911. The silver output of the Park City region in 1912 was 3,642,749 ounces, an increase of 214,098 ounces, or about 6 per cent, over that of 1911. Concentrates produced at milling plants yielded 2,785,154 ounces of silver, against

2,478,012 ounces in 1911. The copper ores milled produced 347,867 ounces from concentrates in 1912, against 431,405 ounces in 1911. Lead concentrates from low-grade lead ore contained 2,247,050 ounces of silver, or an average of 21.61 ounces per ton, against 1,915,322 ounces of silver, or an average of 17.90 ounces per ton in 1911; zinc concentrates contained 11.69 ounces per ton; and copper-lead concentrates, 35.23 ounces per ton. Silver in bullion produced from ores and tailings treated by amalgamation aggregated 46 ounces, against 1,029 ounces in 1911, and that by cyanidation was 64,422 ounces against 111,464 ounces in 1911. In 1912 the testing mill on the Ontario mine fillings was put in operation at Park City, a leaching process being employed.

Source of silver production in Utah, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver		1,582	34,827	214,709	2,651	2,295		256,064
Boxelder		27	950	2,395				3,372
Garfield	6							6
Grand	1	57						58
Iron		236		78				314
Juab		3,256,306	1,392,225	1,924,979	4,434	60,481		6,638,425
Millard			283					283
Morgan				603				603
Piute		478	1,170	1,174				2,822
Salt Lake		64,498	1,112,889	698,418		80,785	262,232	2,218,822
San Juan	5							5
Sevier				3				3
Summit		31,729		2,315,963			606,336	2,954,028
Tooele		22,502	37	507,179		10,530	613	540,861
Uinta	34							34
Utah		109,143		414,479	7,856			531,478
Wasatch				132,239			556,482	688,721
Washington		4						4
Total	46	3,486,562	2,542,381	6,212,219	14,941	154,091	1,425,663	13,835,903

COPPER.

The copper production of Utah in 1912 was 137,307,485 pounds, valued at $22,655,735, and decreased 9,653,342 pounds, caused largely by the 40-day strike of the miners in the Bingham district. In 1911 the output was valued at $18,370,103, but owing to the higher price of copper in 1912 the value was $4,285,632 greater than in 1911. The Bingham district produced 116,621,793 pounds of copper in 1912, against 129,995,865 pounds in 1911, 113,725,280 pounds in 1910, and 92,560,340 pounds in 1909. The Tintic district yielded 13,339,126 pounds in 1912, against 10,922,154 pounds in 1911, an increase of 2,416,872 pounds. The Park City district, of Summit and Wasatch counties, produced 1,968,249 pounds in 1912, against 1,281,190 pounds in 1911. Beaver County yielded 3,040,400 pounds in 1912, against 3,739,282 pounds in 1911. Concentrates recovered at milling plants in Utah contained 104,999,753 pounds of copper, against 107,390,325 pounds produced in 1911. Copper concentrates contained 102,539,091 pounds, against 105,951,588 pounds produced in 1911. Lead concentrates contained 2,315,119 pounds of copper, against 1,394,266 pounds in 1911; zinc concentrates contained 85,376 pounds; and

copper-lead concentrates 60,167 pounds. Crude ore shipped to smelters contained 31,678,257 pounds, against 38,764,871 pounds in 1911. The crude copper ores smelted contained 25,000,452 pounds, of which 14,051,826 pounds were produced from sulphide ores and 10,948,626 pounds from oxidized ores. Lead ores yielded 3,058,179 pounds of copper, the sulphide ores producing 1,994,455 pounds, and oxidized ores 1,063,724 pounds. Copper-lead ores contained 292,839 pounds of copper, of which the oxidized ores contained 260,376 pounds and the sulphide ores 32,463 pounds.

Source of copper production of Utah, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	.....	2,801,984	206,335	660	31,421	.....	3,040,400
Boxelder	.....	843,491	1,762	.....	.....	.....	845,253
Grand	6	.....	.....	.....	.....	.....	6
Juab	3,341,767	9,484,654	479,661	.....	32,982	.....	13,339,064
Millard	.....	2,966	.....	.....	.....	.....	2,966
Morgan	.....	.....	50	.....	.....	.....	50
Piute	.....	2,679	427	.....	.....	.....	3,106
Salt Lake	28,169	114,566,192	1,636,248	.....	233,377	567,600	117,031,586
Summit	3,161	.....	1,063,711	.....	.....	385,949	1,452,821
Tooele	.....	10,203	997,296	.....	57,999	.....	1,065,498
Utah	.....	.....	11,307	.....	.....	.....	11,307
Wasatch	.....	.....	86,201	.....	.....	429,227	515,428
Total	3,373,103	127,712,169	4,482,998	660	355,779	1,382,776	137,307,485

LEAD.

The production of lead in Utah in 1912 was 140,311,135 pounds, valued at $6,314,001, against 136,496,750 pounds, valued at $6,142,354, in 1911. Of the 1912 output, 31 per cent was derived from mines in the Bingham district, which produced 43,822,495 pounds, against 46,576,337 pounds in 1911. The Park City district produced 42,111,561 pounds of lead in 1912, or 30 per cent of the State output. The Tintic district yielded 23,572,966 pounds in 1911 and 24,356,041 pounds in 1912. Beaver County's production of lead increased from 4,534,678 pounds in 1911 to 7,652,669 pounds in 1912. Concentrates, mostly sulphides, were shipped to the smelters and contained 46,532,086 pounds, against 46,847,841 pounds in 1911, averaging 21.88 per cent in 1912 and 21.35 per cent in 1911 of lead in lead concentrates; zinc concentrates contained 938,813 pounds, averaging 3.13 per cent of lead in 1912 and 2.56 per cent in 1911; copper-lead concentrate contained 86,777 pounds of lead, averaging 10.18 per cent in 1912, and 7.88 per cent in 1911. The total crude ore of shipping grade contained 88,710,465 pounds of lead, against 89,591,550 pounds in 1911. Sulphide lead ore predominated and yielded 49,346,148 pounds of lead, the oxidized ores yielding 33,728,628 pounds. Zinc ores contained 624,785 pounds, of which the oxidized ores produced 412,735 pounds of lead and the sulphides 212,050 pounds. Copper-lead ores contained 852,190 pounds, of which the oxidized and carbonate ores produced 798,929 pounds and the sulphides 53,261 pounds. The lead-zinc ores, all oxidized or siliceous in character, contained 201,433 pounds of lead.

Source of lead production of Utah, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	.....	.....	7,390,053	213,768	48,848	.....	7,652,669
Boxelder	.....	.....	85,734	.....	.....	.....	85,734
Iron	.....	.....	5,988	.....	.....	.....	5,988
Juab	1,715,565	2,194,024	15,098,044	173,709	76,734	.....	19,258,076
Morgan	.....	.....	71,730	.....	.....	.....	71,730
Piute	.....	.....	21,889	.....	.....	.....	21,889
Salt Lake	1,075	.....	33,942,315	.....	553,344	10,691,862	45,188,596
Sevier	.....	.....	7,093	.....	.....	.....	7,093
Summit	84,409	.....	23,669,751	.....	.....	8,335,340	32,089,500
Tooele	8,940	.....	18,552,433	.....	262,606	201,433	19,025,412
Utah	.....	.....	6,643,361	239,026	.....	.....	6,882,387
Wasatch	.....	.....	1,489,642	.....	.....	8,532,419	10,022,061
Total	1,809,989	2,194,024	106,978,033	626,503	941,532	27,761,054	140,311,135

ZINC.

The zinc production of Utah was 17,067,177 pounds, figured as spelter, valued at $1,177,635, in 1912, against 17,840,261 pounds, valued at $1,016,895, in 1911. The Park City mining region alone produced 8,001,512 pounds of zinc in 1912, against 8,596,564 pounds in 1911. The yield of this region in 1912 was about 47 per cent of the total zinc production of Utah. The Tintic district was also an important producer, for the first time in the history of the district, and yielded 22 per cent of the zinc output, or 3,709,737 pounds, in 1912. The Bingham district was a large producer, but its output decreased from 4,715,121 pounds in 1911 to 2,711,982 pounds in 1912. The Mount Nebo district, in Juab County, yielded some zinc. Beaver County, which produced 1,176,186 pounds, and Tooele County, which produced 1,234,092 pounds, were the only other counties in which zinc was produced in 1912. The zinc in 14,992 tons of zinc concentrates, containing 10,716,314 pounds as spelter, all came from Summit, Wasatch, Salt Lake, and Beaver counties. Crude zinc ore shipped to smelters contained 5,596,442 pounds in 1912, against 877,876 pounds in 1911. The larger part of the ore produced in 1912 was oxidized or a mixed carbonate and silicate ore and yielded 4,423,076 pounds of spelter, the sulphide ores containing 1,173,366 pounds. Oxidized zinc ores were produced in the Tintic district of Juab and Utah counties, and in the North Tintic district of Tooele County. The sulphides came mainly from Beaver County.

Source of zinc production of Utah, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Beaver	.....	1,176,186	.....	1,176,186
Juab	.....	776,167	.....	776,167
Salt Lake	10,608	.....	2,701,374	2,711,982
Summit	.....	.....	4,338,334	4,338,334
Tooele	.....	479,671	754,421	1,234,092
Utah	.....	3,167,238	.....	3,167,238
Wasatch	.....	.....	3,663,178	3,663,178
Total	10,608	5,599,262	11,457,307	17,067,177

Zinc ore and concentrates, produced from Utah mines and mills, sold in 1912, and source, by counties.

County.	Classification.	Quantity.	Average assay of ore or concentrates.
		Short tons.	*Per cent.*
Beaver and Juab	Sulphide ore	2,031	40.75
Juab and Tooele	Mixed carbonate and silicate ore	2,971	35.17
Utah	do	5,419	34.38
Beaver, Salt Lake, Summit, and Wasatch.	Concentrates and middlings	14,972	42.10
Total	Ore concentrates and middlings	25,393	38.99
SUMMARY.			
Beaver and Juab	Sulphide ore	2,031	40.75
Juab, Tooele, and Utah	Carbonate and silicate ore	8,390	34.66
Beaver, Salt Lake, Summit, and Wasatch.	Concentrates and middlings	14,972	42.10

METAL INDUSTRY IN UTAH IN 1912.

Metal-producing mines in Utah reached a new high mark in total value of output, due to higher prices paid for the metal content of the ores sold. The output might have been greater had the industry not been interrupted by the Bingham labor strike, which retarded production during part of September and all of October. This strike did not hamper the operation of the smelting plants to any great extent, owing to the large ore reserves in their yards. However, the strike did effect the output of several of the large producing mines whose production of copper was expected to bring the total much above the high record of 1911. Mining companies in Utah disbursed dividends aggregating $9,573,207 in 1912, against $8,968,350 paid to stockholders in 1911. All of the dividend-paying companies own mines in Utah. The dividend totals for 1912 include $2,579,882 paid by the United States Smelting Co. owning mines and a smelter in Utah, and also smelters and mines in other States. Therefore, the actual amount of dividends that should be credited to Utah for 1912 and previous years is not exactly known. Part of the ores mined in the Coeur d'Alene district in Idaho, in Nevada, in Montana, and in northern Arizona are smelted at the plants in the Salt Lake Valley, and some lead ore was shipped from Utah to Colorado points. All of

the zinc ores produced find a market in Colorado, Kansas, Oklahoma, and Wisconsin.

A branch line of railroad between Ophir and a connection with the Salt Lake route at St. Johns was completed and does away with the wagon haul of about 16 miles between these two points.

METALLURGICAL INDUSTRY.

Milling plants used in the amalgamation process were operated in Boxelder and Iron counties. Tests by amalgamation were made in Salt Lake and Washington counties. Cyanidation was used at Bingham on siliceous silver ores, and on siliceous gold ores and roasted arsenical ores at Mercur. One plant at Park City is equipped for acid leaching and precipitation of the gold, silver, copper, and lead on scrap metal, each metal precipitating from solution on the metal for which it has the greatest affinity.

There were 171,117 tons of ore treated by the amalgamation, cyanide, and an acid leaching process. The output by the latter was small and in the nature of tests. The treatment of 558 tons of ores and tailings by the amalgamation process produced 140.52 ounces of gold and 46 ounces of silver. At cyanide mills 169,140 tons of ore yielded 21,144.95 ounces of gold and 58,295 ounces of silver. The total bullion output from gold and silver mills was valued at $479,724.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Utah in 1912, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Boxelder	180	[a]123.26	[a] 27	.....	.....	$2,565
Iron	100	6.03	14	.....	.....	134
Piute	310	.....	.....	144.40	454	3,264
Salt Lake	5,258	1.84	1	649.80	57,288	48,703
Summit	[b] 1,669	.....	.....	3.22	6,127	3,835
Tooele	163,582	.....	.....	20,350.72	553	421,027
Washington	18	9.39	4	.....	.....	196
Total	171,117	140.52	46	21,148.14	64,422	479,724

[a] Includes bullion from 250 tons of old tailings.
[b] Includes tests by acid leaching of Ontario low-grade ores.

Concentration of low-grade copper ores and lead ores was accomplished in eight counties. The largest operations were in Salt Lake County at the two mills of the Utah Copper Co., near Garfield, where 19,000 to 21,000 tons of low-grade copper ore were treated daily. Similar ore was treated at a mill in Beaver County. In the Park City region of Summit and Wasatch counties, and in Tooele County, at Ophir, low-grade lead ores were concentrated.

The two following tables give the quantity of ore treated and concentrates, with the metal yield by counties in 1912, also the kinds of concentrate and metal contained in each kind, showing the average content in 1912 compared with the average per ton in 1911:

Mine production of gold, silver, copper, lead, and zinc from Utah concentrates in 1912, by counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	164,731	11,537	687.49	15,247	1,969,007	1,718	2,820	$348,746
Piute	168	42	9.86	1,112	417	20,534	.....	1,881
Salt Lake	6,061,723	308,039	41,253.03	748,128	101,574,954	18,026,326	2,711,982	19,071,054
Sevier	120	5	.....	3	.....	7,093	.....	321
Summit	152,020	32,872	1,486.85	1,340,709	550,469	17,803,326	4,338,334	2,046,594
Tooele	39,636	9,909	84.00	121,279	474,595	2,029,703	.....	245,967
Utah	218	110	16.00	2,194	1,084	110,967	.....	6,852
Wasatch	58,951	18,844	517.84	556,482	429,227	8,532,419	3,663,178	1,060,482
Total	6,477,567	381,358	44,055.07	2,785,154	104,999,753	46,532,086	10,716,314	22,781,896
Subdivision by kinds of concentrates:								
Copper		261,941	36,882.93	347,867	102,539,091	.....	.....	17,895,325
Lead		103,999	6,917.15	2,247,050	2,315,119	45,506,496	.....	3,954,713
Zinc		14,992	253.92	175,229	85,376	938,813	10,716,314	908,775
Copper-lead		426	1.07	15,008	60,167	86,777	.....	23,083

Kinds of concentrates and average metallic content of each kind produced at concentration mills in Utah in 1912 compared with 1911.

Kind of concentrates.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Copper:							
1911	228,583	$3.85	1.89	23.18	.....	.....	$62.79
1912	261,941	2.91	1.33	19.67	.....	.....	68.32
Lead:							
1911	107,006	1.46	17.90	.65	21.35	.....	31.80
1912	103,999	1.37	21.61	1.11	21.88	.....	38.02
Zinc:							
1911	21,482	.06	5.69	.03	2.56	30.62	40.38
1912	14,992	.35	11.69	.28	3.13	35.74	60.62
Copper-lead:							
1911	291	.27	31.00	5.04	7.88	.....	36.40
1912	426	.05	35.23	7.06	10.18	.....	54.18

Only four of the smelters in Utah were active, one copper plant at Garfield and three lead plants at Murray, Midvale, and International. The last plant also operated its copper furnaces part of the year. At Garfield the copper plant was in operation during 1912 with very little interruption.

Mine production of gold, silver, copper, lead, and zinc from Utah crude ore shipped to smelters in 1912, by counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	30,921	640.37	176,044	996,565	6,055,268	1,173,366	$639,387
Boxelder	5,925	10.45	3,345	845,253	85,734	.....	145,598
Grand	1	.....	57	6	.....	.....	36
Iron	11	14.05	300	.....	5,988	.....	743
Juab	383,142	86,470.46	6,613,001	13,096,800	19,079,562	776,167	8,927,607
Millard	21	9.00	283	2,966	.....	.....	849
Morgan	134	.....	603	50	71,730	.....	3,607
Piute	857	13.02	1,256	2,689	1,355	.....	1,546
Salt Lake	507,533	44,612.90	1,409,262	15,433,802	26,931,360	.....	5,547,415
Summit	28,289	1,486.11	1,607,192	901,761	14,284,461	.....	1,810,736
Tooele	37,740	792.43	353,657	302,273	13,939,103	1,234,092	996,167
Utah	37,964	4,775.18	529,120	9,891	6,766,262	3,167,238	948,775
Wasatch	3,730	170.29	132,239	86,201	1,489,642	.....	166,105
Total	1,036,268	138,994.26	10,826,359	31,678,257	88,710,465	6,350,863	19,188,571
Subdivision by kinds of ore:							
Dry or siliceous	196,846	49,822.50	3,410,636	3,326,787	1,763,257	.....	3,755,731
Copper	572,354	68,251.32	2,187,869	25,000,452	2,194,024	.....	6,980,226
Lead	252,888	20,647.98	5,073,891	3,058,179	83,074,776	.....	7,790,239
Zinc	9,391	102.06	14,631	.....	624,785	5,596,442	425,378
Copper-lead	3,387	170.40	138,719	292,839	852,190	.....	175,501
Lead-zinc	1,402	.....	613	.....	201,433	754,421	61,496

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Utah in 1912 compared with 1911.

Kind of crude ore.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	189,424	$5.30	12.94	0.86	0.67	.....	$14.91
1912	196,846	5.23	17.33	.84	.45	.....	19.08
Copper:							
1911	640,729	2.36	3.01	2.55	.03	.....	10.34
1912	572,354	2.46	3.82	2.18	.19	.....	12.19
Lead:							
1911	261,333	1.82	20.66	.50	16.12	.....	28.51
1912	252,888	1.68	20.06	.60	16.42	.....	30.80
Zinc:							
1911	1,316	.....	.....	.....	.....	33.35	38.02
1912	9,391	.22	1.55	.....	3.33	29.80	45.30
Copper-lead:							
1911	2,219	.98	32.83	6.28	16.41	.....	48.85
1912	3,387	1.04	40.96	4.32	12.58	.....	51.82
Lead-zinc:							
1911	8,033	.17	1.03	.02	10.76	23.69	37.46
1912	1,402	.....	.44	.....	7.18	26.90	43.86

The kinds of crude ores smelted are classified into oxidized and sulphide ores with average content in the two following tables:

Oxidized and sulphide crude ores with metal content, by kinds, including mixed dry ores and carbonate ores, produced in Utah and shipped to smelters in 1912.

Kind of ore.	Quantity.	Metal content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	196,846	49,822.50	3,410,636	3,326,787	1,763,257	.....	$3,755,731
Copper:							
Oxidized	147,271	28,576.70	1,414,398	10,948,626	2,194,024	.....	3,365,843
Sulphide	425,083	39,674.62	773,471	14,051,826	.....	.....	3,614,383
Lead:							
Oxidized	119,195	13,509.92	3,160,258	1,063,724	33,728,628	.....	3,916,136
Sulphide	133,693	7,138.06	1,913,633	1,994,455	49,346,148	.....	3,874,103
Zinc:							
Oxidized	7,360	102.06	12,290	.....	412,735	4,423,076	333,434
Sulphide	2,031	.....	2,341	.....	212,050	1,173,366	91,944
Copper-lead:							
Oxidized	3,154	161.57	130,862	260,376	798,929	.....	162,735
Sulphide	233	8.83	7,857	32,463	53,261	.....	12,766
Lead-zinc: Oxidized	1,402	.....	613	.....	201,433	754,421	61,496
Total	1,036,268	138,994.26	10,826,359	31,678,257	88,710,465	6,350,863	19,188,571

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Utah and shipped to smelters in 1912.

Kind of ore.	Quantity.	Average.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces, per ton.*	*Fine ounces, per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous	196,846	0.25	17.33	0.84	0.45	.....	$19.08
Copper:							
Oxidized	147,271	.19	9.60	3.72	.74	.....	22.85
Sulphide	425,083	.09	1.82	1.65	.....	.....	8.50
Lead:							
Oxidized	119,195	.11	26.51	.45	14.15	.....	32.85
Sulphide	133,693	.05	14.31	.74	18.45	.....	28.97
Zinc:							
Oxidized	7,360	.01	1.67	.....	2.80	30.05	45.30
Sulphide	2,031	.....	1.15	.....	5.22	28.89	45.27
Copper-lead:							
Oxidized	3,154	.05	41.40	4.13	12.66	.....	51.60
Sulphide	233	.04	33.72	6.97	11.43	.....	54.80
Lead-zinc: Oxidized	1,402	.....	.44	.....	7.18	26.90	43.86
Total	1,036,268	.13	10.45	1.53	4.28	.31	18.52

MINING INDUSTRY IN UTAH IN 1912.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1912, by counties.

County.	Gold.				Silver.	
	Placers.		Deep mines.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine oz.		*Fine oz.*		*Fine oz.*	
Beaver			1,650.31	$34,115	256,064	$157,479
Boxelder			133.71	2,764	3,372	2,074
Garfield	56.50	$1,168			6	3
Grand	3.82	79			58	36
Iron			20.08	415	314	193
Juab			87,309.23	1,804,842	6,638,425	4,082,631
Millard			9.00	186	283	174
Morgan					603	371
Piute			167.28	3,458	2,822	1,736
Salt Lake			86,529.81	1,788,730	2,218,822	1,364,576
San Juan	30.00	620			5	3
Sevier					3	2
Summit			2,976.18	61,523	2,954,028	1,816,727
Tooele			21,799.32	450,632	540,861	332,630
Uinta	184.45	3,813			34	21
Utah			4,793.33	99,087	531,478	326,859
Wasatch			688.13	14,225	688,721	423,563
Washington			9.39	194	4	2
Total	274.77	5,680	206,085.77	4,260,171	13,835,903	8,509,080

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaver	3,040,400	$501,666	7,652,669	$344,370	1,176,186	$81,157	$1,118,787
Boxelder	845,253	139,467	85,734	3,858			148,163
Garfield							1,171
Grand	6	1					116
Iron			5,988	269			877
Juab	13,339,064	2,200,946	19,258,076	866,613	776,167	53,556	9,008,588
Millard	2,966	489					849
Morgan	50	8	71,730	3,228			3,607
Piute	3,106	512	21,889	985			6,691
Salt Lake	117,031,586	19,310,212	45,188,596	2,033,487	2,711,982	187,127	24,684,132
San Juan							623
Sevier			7,093	319			321
Summit	1,452,821	239,715	32,089,500	1,444,028	4,338,334	299,345	3,861,338
Tooele	1,065,498	175,807	19,025,412	856,144	1,234,092	85,152	1,900,365
Uinta							3,834
Utah	11,307	1,866	6,882,387	309,707	3,167,238	218,539	956,058
Wasatch	515,428	85,046	10,022,061	450,993	3,663,178	252,759	1,226,586
Washington							196
Total	137,307,485	22,655,735	140,311,135	6,314,001	17,067,177	1,177,635	42,922,302

Tons of ore sold or treated, number of deep mines producing, and value of ores in Utah in 1911 and 1912, by counties.

County.	Ore sold or treated. (short tons).		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1912	Increase (+) or decrease (−).	1911	1912	1911	1912	1911	1912
Beaver	209,568	− 50,127	29	18	$3.19	$5.34	$0.59	$0.91
Boxelder	6,355	+ 2,838	8	9	13.31	23.31	2.11	0.76
Garfield	.....	− 100	1	.....	8.29	.....	8.29	.....
Grand	1	− 5	1	1	41.17	36.00	32.17	35.00
Iron	111	− 91	3	3	11.54	7.90	11.54	5.48
Juab	388,582	+ 87,256	39	42	19.98	23.18	13.20	15.15
Millard	21	− 56	3	2	33.14	40.43	22.00	17.14
Morgan	134	+ 108	1	1	32.50	26.93	3.27	2.78
Piute	1,335	− 1,823	5	4	9.44	5.01	9.13	3.89
Salt Lake	6,576,547	+525,505	49	53	3.73	3.75	0.63	0.48
Sevier	120	− 1,171	1	1	0.63	2.67	0.63	0.02
Summit	217,990	− 18,877	22	15	16.22	17.75	6.79	8.62
Tooele	268,605	− 22,526	21	32	5.33	7.07	2.51	2.92
Utah	38,202	− 22,407	15	13	17.70	25.03	10.40	11.15
Wasatch	62,681	+ 3,198	2	3	14.64	19.57	5.23	6.98
Washington	18	+ 18	.....	1	.....	10.89	.....	10.89
Total	7,770,270	+501,740	200	198	5.07	5.52	1.55	1.64

[a] Value per ton, placer product excluded.

Number of mines classified by chief products in Utah, in 1912, by counties.

County.	Mines reporting product.	Gold placer mines.	Deep mines.							
			Gold and silver.	Gold, silver, and copper.	Gold, silver, copper, and lead.	Gold, silver, copper, lead, and zinc.	Gold, silver, and lead.	Silver and copper.	Silver and lead.	Silver, lead, and zinc.
Beaver	18	.....	1	3	10	2	2	.....	.....	.....
Boxelder	9	.....	2	.....	[a] 6	.....	1	.....	.....	.....
Garfield	4	4	.....	.....	.....	.....	.....	.....	.....	.....
Grand	4	3	.....	.....	.....	.....	.....	1	.....	.....
Iron	3	.....	2	.....	.....	.....	.....	.....	1	.....
Juab	42	.....	1	6	[b] 25	6	3	1	.....	.....
Millard	2	.....	.....	2	.....	.....	.....	.....	.....	.....
Morgan	1	.....	.....	.....	.....	.....	1	.....	.....	.....
Piute	4	.....	2	1	1	.....	.....	.....	.....	.....
Salt Lake	53	.....	2	7	[c] 29	9	5	1	.....	.....
San Juan	1	1	.....	.....	.....	.....	.....	.....	.....	.....
Sevier	1	.....	.....	.....	.....	.....	.....	.....	1	.....
Summit	15	.....	.....	.....	8	6	.....	.....	.....	1
Tooele	32	.....	[d] 6	18	2	[e] 4	.....	.....	1	1
Uinta	1	1	.....	.....	.....	.....	.....	.....	.....	.....
Utah	13	.....	.....	.....	[a] 7	1	3	.....	.....	[f] 2
Wasatch	3	.....	.....	.....	2	1	.....	.....	.....	.....
Washington	1	.....	1	.....	.....	.....	.....	.....	.....	.....
Total	207	9	17	37	90	29	15	3	3	4

[a] 1 contains no gold.
[b] 1 contains no copper.
[c] 4 contain no gold.
[d] 1 contains only silver.
[e] 1 contains only zinc.
[f] Contain also gold.

REVIEW BY COUNTIES.

BEAVER COUNTY.

Quantity of ore sold or treated in Beaver County, Utah, in 1905–1912, number of mines producing, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	5	143,233	$38,512	180,912	3,555,918	4,203,156	1,358,000	$980,176
1906	14	244,777	56,396	323,807	5,406,068	5,324,508	780,276	1,667,812
1907	17	234,092	55,968	351,147	5,639,444	4,458,996	1,039,144	1,713,251
1908	21	223,021	47,147	150,193	5,706,406	3,089,141	54,902	1,012,319
1909	20	57,867	15,771	273,977	1,247,235	5,766,356	656,457	603,782
1910	21	83,748	17,114	339,881	1,128,785	6,235,535	513,733	646,111
1911	29	259,695	47,568	201,259	3,739,282	4,534,678	64,927	829,406
1912	18	209,568	34,115	256,064	3,040,400	7,652,669	1,176,186	1,118,787
Increase (+) or decrease (−) in 1912	.....	−50,127	−13,453	+54,805	−698,882	+3,117,991	+1,111,259	+289,381

The gold output from Beaver County mines decreased from $47,568 in 1911 to $34,115 in 1912, or $13,453. The silver production, valued at $106,667 in 1911, increased to $157,479, or an increase of $50,812, in 1912. The copper yield decreased in quantity, but in total value increased from $467,410 to $501,666, or $34,256 more than in 1911. The lead production in 1912 was the largest in seven years, the value of its increase amounting to $140,310, or an increase from $204,060 to $344,370 in 1912. The zinc output figured as spelter also increased, with a total value of $3,701 in 1911 and of $81,157 in 1912. The total value of all the metals was $1,118,787 in 1912, an increase of $289,381.

Reports from 18 deep mines in 1912, against 29 in 1911, gave a yield of 209,568 tons of ore, which was 50,127 tons less than in 1911. The total average value per ton of this ore increased from $3.19 in 1911 to $5.34 in 1912, and the average value of the gold and silver content increased from 59 cents to 91 cents per ton. Of the ore mined, 164,731 tons were milled, producing concentrate containing gold, silver, copper, lead, and zinc, valued at $348,746, at an average value of $30.23 per ton. The larger part of the product was copper concentrate, produced from low-grade disseminated ores from the Cactus mine and milled at Newhouse. Crude shipping ore aggregated 30,921 tons, largely sulphides, and yielded at smelters gold, silver, copper, lead, and zinc, valued at $639,387, at an average value of $20.68 per ton.

Bradshaw district.—Lessees operated the Cave mine, and only one small shipment of oxidized iron ore, carrying copper, silver, and gold, was made.

Newton district.—The Sheep Rock mine was productive of a small quantity of shipping grade siliceous gold-silver ore, mined by lessees. An amalgamation mill is under construction to treat the ores from this mine and other ores offered from the neighboring properties.

Rocky district.—The Old Hickory mine yielded the largest quantity of oxidized copper ore, and from the Montreal mine similar ore was shipped to the smelter at Garfield.

San Francisco district.—Six producers reported the production of 189,374 tons of ore, containing $29,974 in gold, 183,318 ounces of silver, 2,213,911 pounds of copper, 4,719,637 pounds of lead, and 1,173,366 pounds of zinc, valued in all at $801,355. In 1911 there were 254,444 tons of ore mined in the district, having a total value of $676,569. The Cactus mine yielded the largest part of the tonnage, consisting of low-grade monzonite porphyry ore, which was milled at Newhouse, and the copper sulphide concentrates were shipped to the smelters. The next largest output of ore came from the Horn Silver mine, which produced a shipping ore of mixed lead sulphides and carbonates, also an important tonnage of zinc sulphide ore. The concentrates produced in the district aggregated 11,521 tons, containing 687.36 ounces of gold, 14,937 ounces of silver, and 1,968,347 pounds of copper. Ore of shipping grade aggregated 10,758 tons, containing 440.18 ounces of gold, 103,608 ounces of silver, 170,736 pounds of copper, 3,123,954 pounds of lead, and 1,173,366 pounds of zinc. In addition to the crude ore, there were 13,916 tons of old slags loaded and shipped to the smelters.

The Horn Silver mine[1] was operated under difficulty, owing to the cave-in of the shaft and some of the old stopes. However, there were shipped 6,999 tons of carbonate and sulphide lead ore, 2,031 tons of sulphide zinc ore, 6,335 tons of tailings, 4,484 tons of old slag, and 30 tons of dump ore.

The development work totaled 1,483.5 feet, 208 feet being in Lulu ground, the 700 South Drift extending into the Lulu claim, January 1, 1913, 192 feet and the 900 South Drift, 16 feet. The development has been mainly to the south. One lead stope and two zinc stopes were opened up as a result, these being southern continuations of the main ore bodies. These stopes were not affected by the recent cave-in in the old stopes. The development work further to the south and in the Lulu claim has given negative results so far.

The Cactus mine[2] yielded 426,703 tons of ore, from which was produced 5,527,810 pounds of copper, 43,691.71 ounces of silver, and 2,449.96 ounces of gold. The average assay content of the material shipped is as follows:

Average assay per ton of mill ore, crude ore, and concentrates treated and shipped from the Cactus mine, Beaver County, Utah, during 18 months ending June 30, 1912.

Kind of material.	Tonnage.	Gold.	Silver.	Copper.	Iron.
	Short tons.	*Fine ounces, per ton.*	*Fine ounces, per ton.*	*Per cent.*	*Per cent.*
Crude ore milled	426,002	.....	.....	1.142	.....
Copper sulphide concentrates shipped	34,062	0.0708	1.380	8.438	28.86
Crude copper sulphide ore shipped	701	.0533	2.201	12.390	27.58

The average mill recovery was 59.09 per cent, and the average ratio of concentration was 12.51 tons of ore to 1 ton of concentrates produced. The mine cost was $0.8345 per ton of ore, and the cost per pound of copper produced was $0.0644. The mill cost was $0.6723 per ton, equal to $0.0519 per pound of copper.

The capacity of the mill has been raised from 800 to 1,000 tons per day by improvements to the rolls and elevators, by replacing the fine screens with three hydraulic

[1] Ann. Rept. for year ending Dec. 31, 1912.
[2] Report South Utah Mines and Smelters, 18 months, ending June 30, 1912. Emmons, S. F., The Cactus copper mine, Utah: Bull. U. S. Geol. Survey No. 260, 1905, pp. 242–248.

classifiers, by the installation of coarser preliminary trommels, by increasing the grade and capacity of the tail race, and by improvements to the water system. * * * An attempt was made to re-treat part of the old tailings' dump, which assayed about 1 per cent copper, but it was abandoned, due to lack of facilities for sufficient fine grinding. During the last eighteen months the character of the ore has changed from a coarsely disseminated chalcopyrite to a more finely disseminated ore, requiring finer crushing to liberate the free mineral. * * * The No. 2 French ore body is the most promising find of the year. This body has been opened on the 600 level for a length of 125 feet and a width of 135 feet. As yet, the ore body has not been reached on any other level * * *. This body extends in an east and west direction and only the south wall has been found. The main west development drift and the north crosscut are both averaging 1.80 per cent. This ore is in virgin ground to the surface, and if its development on the other levels is as favorable as on the 600 level, it will be a big asset to the mine.

Star districts (North and South).—There were 5,144 tons of ore treated, of which 5,113 tons were shipped directly to smelters by 7 producers, as against 4,734 tons shipped by 14 producers in 1911. The total output, valued at $175,554 in 1912, contained $1,314 in gold, 51,355 ounces of silver, 67,875 pounds of copper, 2,916,957 pounds of lead, and a small quantity of zinc, the last from a small test at the Midvale zinc mill of the United States smelter. The Moscow mine was the largest shipper of ore, and others of importance were the Red Warrior, St. Mary, Harrington-Hickory, Progressive, and Rebel properties.

BOXELDER COUNTY.

Lucin district.—All of the ore mined by 7 producers was shipped directly to smelters, and consisted of 5,925 tons, containing $216 in gold, 3,345 ounces of silver, 845,253 pounds of copper, and 85,734 pounds of lead, valued in all at $145,598. The Copper Mountain property, owned by the Salt Lake Copper Co., produced oxidized copper ore and some lead ore, mined almost entirely by lessees. Other producers were the Tecoma mines, the Mineral Hill, and a property operated by the Copper Mountain Mining Co.

Park Valley district.—The principal production was from the Susannah and the Century properties. Ore was crushed in the Lane mill of the Susannah mine and bullion was recovered by amalgamation. Some old tailings were run through placer sluices from the Century mill dump and produced gold and silver bullion.

GRAND COUNTY.

La Sal district.—Lessees operated the High Ore property and made one small shipment of ore containing mostly silver.

IRON COUNTY.

Pinto district.—A trial shipment made from the Homestake property contained principally lead with a little silver.

Stateline district.—The Big Fourteen property produced milling ore, which was treated by amalgamation and cyanidation.

JUAB COUNTY.

There were 42 deep mines producing in 1912, against 39 in 1911, and the total value of the product—gold, silver, copper, lead, and zinc—was $9,008,588, produced from 388,582 tons, or 87,256 tons

more than was produced in 1911. The larger part of this output was from the Tintic district, which has the larger part of its mineral area in this county, the smaller part lying in Utah County.

Fish Springs district.—The principal producer was the Utah mine, from which was shipped carbonate lead-silver ore carrying a little gold and a trace of copper. Small shipments of similar ore were also made from the Emma and Carnation groups.

Johnson's Peak district.—The Minnehaha was a producer of oxidized gold-silver-copper ore. The property is developed by a 100-foot shaft and has 185 feet of drifts.

Mount Nebo district.—All of the ore produced from 4 properties was of shipping grade and aggregated 1,429 tons, containing $220 in gold, 16,152 ounces of silver, 472 pounds of copper, 832,246 pounds of lead, and 233,668 pounds of zinc, valued in all at $63,805. The largest part of the shipments was from the Eva mine, which yielded a good grade of mixed lead sulphide and carbonate ore and an oxidized zinc ore. The Eva property is opened by an incline shaft 55 feet deep and has 200 feet of drifts. The Fredie Lode, the next important shipper, is opened by a tunnel 600 feet long. The Nebo Star and Spider properties were also producers.

Tintic district.[1]—The following table shows the production of the district from 1904 to 1912:

Number of mines producing and total tons of ore sold or treated in Tintic district, Juab and Utah counties, in 1904–1912, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	35	262,680	$1,487,558	3,938,630	9,035,720	22,122,312	.....	$5,842,740
1905	31	266,761	2,086,656	3,951,348	10,982,751	18,702,573	.....	7,125,651
1906	31	317,576	1,925,066	4,610,794	7,321,471	32,022,190	.....	8,252,607
1907	40	278,504	2,337,270	4,949,082	7,755,831	33,019,242	.....	8,904,848
1908	42	260,104	1,307,464	4,118,440	5,707,786	25,045,882	.....	5,295,591
1909	37	256,578	1,719,679	6,404,847	5,915,669	56,502,209	.....	8,248,831
1910	40	300,631	1,370,320	5,222,742	8,993,036	37,553,445	.....	6,985,068
1911	38	360,391	1,633,396	5,514,702	10,922,154	23,572,966	.....	6,982,241
1912	40	423,830	1,900,731	7,073,104	13,339,126	24,356,041	3,709,737	9,803,640
Increase in 1912	.....	+63,439	+267,335	+1,558,402	+2,416,972	+783,075	+3,709,737	+2,821,399

Division of Tintic district metallic output in 1912, compared with the 1911 output, by counties.

County.	Year.	Number of mines.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
			Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Juab	1911	31	300,313	72,553.46	4,590,023	10,918,410	14,173,907	.....	$5,935,152
	1912	34	386,539	87,275.99	6,554,091	13,331,493	17,924,578	542,499	8,878,655
Utah	1911	7	60,078	6,462.08	924,679	3,744	9,399,059	.....	1,047,089
	1912	6	37,291	4,671.91	519,013	7,633	6,431,463	3,167,238	924,985

[1] Tower, G. W., and Smith, G. O., Geology and mining industry of the Tintic district, Utah: Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1899, pp. 601–767.

From 40 mines in 1912, there were shipped 423,830 tons of ore, as against 38 properties producing 360,391 tons in 1911. The entire output was of shipping grade and was valued at $9,803,640, or an average of $23.13 per ton. The output in 1911 amounted in value to $6,982,241, or an average of $19.37 per ton. In 1910 the average value was $23.23 per ton. Large quantities of dump ore mined in the early days were shipped and small quantities of tailings and slag from the old milling and smelting plants operated in the seventies were also shipped. There was no ore milled in the district in 1912. Increases in total value were made for all the metals produced. The output of gold increased from $1,633,396 in 1911 to $1,900,731 in 1912; the silver yield, valued at $2,922,792 in 1911, increased to $4,349,959 in 1912; the copper production, valued at $1,365,269 in 1911, increased to $2,200,956 in 1912; the lead yield increased in value from $1,060,784 to $1,096,022 in 1912; and the zinc output, figured as spelter, was $255,972 in 1912; and all the metals aggregated a total value of $9,803,640, an increase of $2,821,399.

Mine production of Tintic district, Juab and Utah counties, in 1912, by kinds of ore and metal output of each.

Kind of ore.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Siliceous	21	194,606	49,243.90	3,365,449	3,341,767	1,715,565	.....
Copper	13	128,842	29,070.01	1,392,116	9,479,915	2,194,024	.....
Lead	22	93,604	13,476.09	2,246,510	484,462	20,129,216	.....
Zinc	8	6,306	100.06	8,548	.....	240,502	3,709,737
Copper-lead	4	472	57.80	60,481	32,982	76,734	.....
Total	.....	423,830	91,947.86	7,073,104	13,339,126	24,356,041	3,709,737

Dry or siliceous ores were produced from the Centennial-Eureka, Chief Consolidated, Eagle & Blue Bell, and Swansea mines in the largest quantities; copper ores from the Centennial-Eureka, Mammoth, Gold Chain, and Grand Central; and lead ore from the Iron Blossom and the Gemini. The largest quantities of zinc ore were produced from the May Day and Yankee mines, with lesser quantities from the Lower Mammoth, East Tintic Development, Uncle Sam, Gemini, Godiva, and Ridge & Valley mines. Copper-lead ore was produced from the Mammoth, Undine, and Shoebridge properties. Zinc silicate and carbonate ores, which had been previously overlooked or not recognized by the miners in the district, formed quite an important item in the total value of the district output for 1912. The occurrence of these ores is described by Zalinski.[1]

The zinc ores are all oxidized. The ore occurs in the limestone along the bottom and lower east side of the lead stopes, though zinc occurs in a few places in the hanging wall of the lead ore. In size and shape the zinc deposits are, if anything, more irregular than the replacement lead-ore bodies. There is some tendency toward flat or lens-shaped deposits along the bedding of the limestone, parallel in places to the bottom of the stopes. The thickness of the zinc ore varies greatly, ranging from a few inches to several feet. Where northeast fissures or breaks cross the lead-ore

[1] Zalinski, E. R., Occurrence of oxidized zinc ores at Tintic: Eng. and Min. Jour., June 21, 1913, p. 1228.

bodies, the thickness of the zinc ore is greater than the average. The ore was not deposited at all points along the bottom of the lead stopes, and the lateral extent of any particular exposure is limited. As often occurs in the Tintic district, little ore is usually blocked out. * * * While the zinc ores are relatively close to the lead stopes, and in most cases border them directly, there are some places where zinc ores have been found to extend 30 to 60 feet below the main ore bodies down on the dip of the limestone bedding or along breaks. The zinc occurs largely on the east sides of the lead stopes, showing the influence of leaching along the bedding. The beds dip to the east. There is no gold or silver in the ore at either property * * * Yankee or May Day. * * * The ore is usually 2 or 3 feet thick, but may reach 6 feet and more at certain points. Zinc is found in larger amounts than usual along east-west and north-east breaks, crossing the ore bodies. So far no zinc ore has been found independent of the lead stopes, and away from their immediate vicinity. At the Yankee and the May Day, zinc ore is being mined over a vertical range of several hundred feet from above the tunnel levels down to the 500-foot level in the latter property. At other mines in Tintic it is found at greater depth, being mined at the Gemini and Ridge & Valley as deep as the 1,400 and 1,600 foot levels, and at the lower Mammoth between the 1,400 and 1,800 foot levels.

The average assay of zinc ore shipped from the May Day mine in 1912 was 0.027 ounce of gold, 2.20 ounces of silver, and 2.57 per cent of lead, but these metals are not paid for by the zinc buyers, and therefore arises the erroneous supposition that there is no gold or silver in the zinc ore at either the May Day or the Yankee properties.

The Centennial-Eureka mine [1] was the largest ore producer in the district in 1912.

Developments continued on a large scale and considerable ore was put in sight. This addition was not quite equal to the extraction, which amounted to 117,957 tons. Slow progress was made on the 2,000-foot level. The cost, due to the heavy flow of water, was very high, and it was considered good policy to suspend operations in that level for the time being. Development work on the Bullion Beck and Champion Mining Co.'s property, in which the Centennial-Eureka Co. holds a majority interest, did not disclose anything of importance. A small force of men continues the work of opening up the country.

The Eureka Hill property was operated by lessees who shipped an important tonnage of oxidized ores of copper and lead taken from the upper levels of the mine.

According to the annual report for the Chief Consolidated mine,[2] it yielded in 1912 silver ore aggregating 30,038 tons, containing 7,682 ounces of gold, 895,885 ounces of silver, and 817,090 pounds of lead. The average assay per ton was 0.25 ounce of gold, 29.82 ounces of silver, and 1.36 per cent of lead. Ore is reported to have been developed on the 1,000, 1,200, 1,400, and 1,600 foot levels. The sinking of the shaft has again been started and will shortly reach the 1,800-foot level. A connection with the Gemini mine, 2,000 feet distant, has also been started in both mines.

The Eagle & Blue Bell mine [3] produces both silver-lead and a dry or siliceous ore carrying gold and silver. With respect to tonnage handled, 1912 is the company's best year, showing a total production of 22,341 dry tons, having a gross value of $346,403.13. The net smelter returns amount to $207,411.17, after deducting freight and treatment charges. * * * The metal content of the ore was 5,833 ounces of gold, 341,164 ounces of silver, 1,303,294 pounds of lead, and 50,913 pounds of copper.

At the Colorado mine [4] shipping ore was mined aggregating 11,191 tons, containing 1,584.50 counces of gold, 289,664 ounces of silver, and 1,823,172 pounds of lead, valued in all at $247,899, or an average of $22.15 per ton.

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[1] Ann. Rept United States Mining Co. for year ending Dec. 31, 1912.
[2] Ann. Rept. for year ending Dec. 31, 1912.
[3] Ann. Rept. Bingham Mines Co. for year ending Dec. 31, 1912.
[4] Ann. Rept. for year ending Nov. 1, 1912.

There is developed a considerable tonnage of low-grade siliceous ore, and as the erection of a mill to handle this is now assured, it will no doubt be mined at a profit. A small tonnage of shipping ore is still being sent to the smelters, but it is impossible to say what the future will be in this respect, as the present source of production, being only stringers and offshoots, is uncertain.

Much interest was created in the Yankee mine [1] through the discovery of large bodies of mixed carbonate and silicate zinc ore, assaying from 35 to 40 per cent, of which 1,598 tons were mined and shipped. All of the waste dump material, aggregating 8,492 tons, mined years ago, was found to average per ton $1.63 in gold, 7.18 ounces of silver, and 4 per cent of lead. This was shipped to local smelters at a small profit. In addition, lead-silver ore was shipped by lessees which assayed from 15 to 42 per cent of lead and from 8 to 40 ounces of silver, and $1.45 to $7.65 in gold per ton. Development work continues on the 2,000-foot level.

Work at the Iron Blossom mine[2] opened up shipping ore as deep as the 700-foot level of the No. 1 workings, and the vein was reported strong at that depth. The total output of the mine for the fiscal year aggregated 31,855 dry tons of ore, containing 6,806 ounces of gold, 881,564 ounces of silver, 2,256,892 pounds of lead, and 153,719 pounds of copper, valued in all at $709,172, at an average value of $22.26 per ton. The low-grade siliceous ores are being reserved for treatment in the new mill to be constructed in 1913.

From the Mammoth mine, lessees shipped some ore but the bulk of the tonnage came from an old waste dump which was mined in earlier days. This proved of value in 1912. Other important producers of shipping ore were the Swansea, Grand Central, Gemini, Opohongo, and Victoria mines.

MILLARD COUNTY.

The Copper Head and Victor properties in the Detroit district yielded small quantities of copper ore, containing gold and silver, shipped from Oasis to the smelters.

MORGAN COUNTY.

Shipments of lead oxidized ore, containing some silver, were made from one mine in the Argenta district.

PIUTE COUNTY.

Gold Mountain district.—A clean-up of bullion from the Sevier-Miller mill comprised the only output of the district. Development was carried on steadily at this property. The Annie Laurie mine,[3] a famous producer in the past, was idle.

Ohio district.—The principal shipments were lead concentrates from the Bully Boy mine, containing gold and silver, and a small shipment of copper ore from the Shamrock property.

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[1] Ann. Rept. Yankee Consolidated Mining Co. for year ending Dec. 31, 1912.
[2] Ann. Rept. for year ending Dec. 1, 1912.
[3] Lindgren, W., The Annie Laurie mine, Piute County, Utah: Bull. U. S. Geol. Survey No. 285, 1906, pp. 87–90.

SALT LAKE COUNTY.

The total quantity of ore mined from 53 mines in Salt Lake County aggregated 6,576,547 tons in 1912, which is 525,505 tons more than in 1911, when there were 49 producing properties. The total average value per ton of the ore for the gold, silver, copper, lead, and zinc content increased from $3.73 in 1911 to $3.75 in 1912, and the gold and silver value of this ore decreased from 63 cents to 48 cents per ton. The bulk of the ore was mined by steam shovels at Bingham, in the West Mountain district, and an important tonnage was also shipped directly to the smelters in Salt Lake Valley.

Big Cottonwood and Little Cottonwood districts.—The combined production for these districts for eight years is given in the following table:

Number of mines producing in Big Cottonwood and Little Cottonwood districts, and total tons of ore sold or treated in 1905–1912, and total content of gold, silver, and associated metals.

Year.	Number of producers.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	6	26,003	$19,638	371,683	811,639	1,702,258	$450,756
1906	10	20,801	15,753	345,102	1,193,743	1,922,276	586,933
1907	11	19,896	20,195	399,417	1,074,238	2,337,924	622,568
1908	21	5,866	6,643	63,246	269,212	603,840	101,061
1909	15	13,208	6,940	158,867	1,842,711	332,475	343,400
1910	17	14,203	7,894	202,010	804,018	1,102,907	267,617
1911	12	6,040	2,877	158,448	407,719	1,043,608	184,783
1912	15	6,566	2,945	186,183	386,963	1,135,191	232,381
Increase (+) or decrease (−) in 1912	.....	+526	+68	+27,735	−20,756	+91,583	+47,598

The Black Bess property in the Big Cottonwood section was consolidated in 1912 with the City Rocks and other properties in the Little Cottonwood district, and the larger part of the holdings of the new organization, the Michigan-Utah Mining Co., is in the latter district. Four producers were reported from the Big Cottonwood district, the largest of which was the Cardiff property, yielding copper sulphide and lead oxidized ores. Lessees shipped from the Maxfield property, and a test lot of ore was mined from the Reed Peak claim. The old Jefferson mine yielded gold and silver bullion recovered in mill tests. Hereafter the ore will be treated by amalgamation in the newly equipped plant of the Wasatch-Utah Co. now under construction.

The principal producers of the Little Cottonwood section were the Michigan-Utah mines, yielding copper-lead and lead ore, mostly carbonates, containing silver and gold. The Columbus, Alta Consolidated, and the South Hecla groups were next in importance of ore shipments. The 150-ton concentrating mill of the Columbus mine was operated, producing sulphide concentrates carrying lead, copper, silver, and gold. Other producers were the Albion, Cabin, and Golconda mines.

Smelter district.—The old sites of the Germania, Hanauer, and Franklin smelters, which operated for several years, continue to be a

source of revenue to lessees, who, in 1912, sorted 2,033 tons of slag and matte for the smelters, containing $253 in gold, 4,143 ounces of silver, 22,830 pounds of copper, and 230,190 pounds of lead, valued in all at $16,959.

West Mountain or Bingham district.—The mine output aggregated 6,567,948 tons in 1912, against 6,044,893 tons in 1911. The total value was $24,434,792, or an average value of $3.72 per ton. The number of mines producing and the production of ore and its content for eight years is shown in the following table:

Number of mines producing and total tons of ore sold or treated in West Mountain or Bingham district in 1905–1912, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	21	1,012,009	$1,316,817	1,980,583	39,219,734	23,494,879	.....	$9,735,627
1906	25	996,121	1,632,786	1,927,350	39,424,276	22,927,661	.....	11,839,873
1907	29	1,503,082	1,565,483	1,786,580	45,431,964	21,971,064	.....	12,995,485
1908	27	2,691,640	1,248,221	1,053,146	71,155,740	15,169,518	.....	11,836,067
1909	24	4,166,992	1,521,436	1,615,394	92,560,340	30,365,819	649,542	15,735,090
1910	31	5,427,953	1,767,992	1,800,410	113,725,280	30,271,016	3,572,347	18,708,156
1911	32	6,044,893	2,281,943	2,786,810	129,995,865	46,576,337	4,715,121	22,373,132
1912	32	6,567,948	1,785,532	2,028,496	116,621,793	43,822,495	2,711,982	24,434,792
Increase(+) or decrease (−) in 1912	.....	+523,055	−496,411	−758,314	−13,374,072	−2,753,842	−2,003,139	+2,061,660

A decrease of $496,411 in gold production as compared with the output of 1911 brought the value of the production to $1,785,532 in 1912. The value of the silver yield decreased also and amounted to only $1,247,525 in 1912, against $1,477,009 in 1911. The copper production increased in total value from $16,249,483 in 1911 to $19,242,596 in 1912. The output of lead decreased in total value from $2,095,935 in 1911 to $1,972,012 in 1912, and that of zinc from $268,762 in 1911 to $187,127 in 1912. In 1912 the shipments of ore to the smelters aggregated 502,682 tons, against 661,852 tons in 1911, and 496,773 tons in 1910. The concentrating ores aggregated 6,060,018 tons, against 5,369,388 tons treated in 1911. The concentrates produced were 307,613 tons in 1912, against 271,932 tons in 1911. The crude smelting ore consisted principally of low-grade copper sulphides and contained 44,473.35 ounces of gold, 1,238,088 ounces of silver, 15,107,006 pounds of copper, and 25,882,946 pounds of lead, valued in all at $5,338,158, or an average value of $10.62 per ton. The 307,613 tons of concentrates produced, from ores mined in the camp, contained 41,251.96 ounces of gold, 733,120 ounces of silver, 101,514,787 pounds of copper, 17,939,549 pounds of lead, and 2,711,982 pounds of zinc, valued in all at $19,047,969, or an average of $61.92 per ton. Silver-gold bullion, extracted from siliceous ores mined from the Telegraph property, was treated in the cyanide mill of the Utah Leasing Co. A detailed description of the district is given by Boutwell.[1]

[1] Boutwell, J. M., Economic geology of the Bingham district, Utah: Prof. Paper U. S. Geol. Survey No. 38, 1905, pp. 73–385.

The number of mines and the different kinds of ore produced in 1912 are given in the following table:

Output of ore and production of metals in Bingham district, Utah, in 1912, by kinds of ore.

Kind of ore.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Siliceous	5	6,680	1,136.64	64,497	28,169	1,075	.....
Copper	15	6,355,499	75,846.04	1,085,265	114,480,554	.....	.....
Lead	22	138,889	5,915.18	616,162	1,544,474	33,125,882	10,608
Copper-lead	1	15	17.92	340	996	3,676	.....
Lead-zinc	8	66,865	3,459.33	262,232	567,600	10,691,862	2,701,374
Total	[a]51	6,567,948	86,375.11	2,028,496	116,621,793	43,822,495	2,711,982

[a] There were only 40 producing mines, but more than one kind of ore was mined at several of them.

The mining by steam shovels of low-grade disseminated copper ores aggregated 6,100,533 tons and constituted 92.8 per cent of the total tonnage output of the district. It was the source of 74.7 per cent of the total copper produced in Utah, of 17.4 per cent of the gold, and of 2.6 per cent of the silver recovered. In 1911 the tonnage mined by steam shovels aggregated 5,231,791 tons, which was 86.5 per cent of the total tonnage of the district. An important tonnage of this low-grade ore was mined by the caving system at the Ohio Copper property and treated in its mill situated at Lark.

The net yield of the Utah Copper mine [1] in 1912 was 91,366,337 pounds of copper, 34,255.76 ounces of gold, and 311,391 ounces of silver, which, with a small amount of royalty from lessees, returned a revenue of $15,345,953.

* * * Revised calculations, taking into account the result of the year's work, show that previous to January 1, 1913, there had been developed in the property 337,700,842 tons of ore, of which quantity 257,584,500 tons are classed as fully developed and 80,116,342 tons as partially so. This tonnage includes about 28,800,000 tons of partially developed ore in the slopes of the steam-shovel workings. The average assay of the fully developed ore is slightly in excess of 1.60 per cent copper, and the average assay of the partially developed ore is 1.16 per cent, making the average assay of the total of both classes of ore 1.50 per cent copper. There was mined prior to January 1, 1913, from the entire property, a total of 21,200,842 dry tons of ore, averaging 1.542 per cent copper, and the total reserves remaining amount, therefore, to 316,500,000 tons, averaging 1.495 per cent copper. * * * Of the total ore mined during 1912, 77.81 per cent was obtained by steam shovels from the original Utah mine; 4.33 per cent was mined underground in the Utah mine; and 17.86 per cent was mined underground in the Boston mine; as compared with 74 per cent, 4 per cent, and 22 per cent, respectively, for the previous year. * * * During 1912 there were milled at the Magna plant 3,454,800 tons of ore, a decrease of 270,604 tons as compared with the previous year; while at the Arthur plant, the full capacity of which was not required throughout the year, 1,860,521 tons were milled, this being an increase of 905,124 tons as compared to the previous year. Therefore the total ore treated at both plants for the year was 5,315,321 tons, as compared with 4,680,801 tons for the previous year. During the summer months the Magna plant demonstrated its ability to handle over 12,000 tons of ore daily, when the supply was plentiful and regular, and under the same conditions the reconstructed Arthur plant has shown a capacity of over 8,000 tons per day. * * * The average grade of the ore treated at both plants for the year was 1.3642 per cent copper, as compared with 1.51 per cent copper for the year 1911. This decrease was due principally to the disturbed condi-

[1] Ann. Rept. for year ending Dec., 1912.

tions prevailing at the mines during the latter part of the year, which interfered with stripping operations and caused practically an entire suspension of underground mining. * * * The average recovery for the year at the Magna plant was 66.03 per cent and at the Arthur plant 66.86 per cent. The average recovery at both plants was 66.32 per cent, corresponding to 18.09 pounds of copper per ton, as compared to an average recovery of 69.53 per cent, or 21.03 pounds of copper per ton, for the previous year. The lower percentage of recovery was due in part to the lower average grade of the ore milled and in part to the inferior quality of ore and disturbed operating conditions prevailing throughout the last quarter. * * * The total gross production of copper contained in concentrates for the year 1912 was 96,175,090 pounds, as compared to 98,436,224 pounds for the year 1911. The concentrates produced averaged 20.75 per cent copper, as compared to 25.62 per cent for the previous year. * * * The average cost for the year of mining, transportation, and milling per dry ton of ore, as compared with the years 1910 and 1911, it as follows:

Average cost per ton of ore, Utah Copper Co., Utah, 1912.

Year.	Mining.	Transportation.	Milling.	Total.
1910	$0.4097	$0.2978	$0.4663	$1.1738
1911	0.4479	0.3078	0.4168	1.1725
1912	0.4233	0.2848	0.4158	1.1239

The Highland Boy property [1] yielded in 1912 6,506,814 pounds of copper, 8,734,398 pounds of lead, 230,004 ounces of silver, and 14,042 ounces of gold recovered from 183,386 dry tons of ore, the bulk of which was shipped directly to the smelter and a small quantity of which was concentrated at the Winnamuck mill. The output was classified as follows:

Average assay per ton of crude ore, mill ore, and concentrates produced from the Highland Boy mine in Utah in 1912.

Kind of material.	Dry ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*
Copper iron sulphide ore shipped	159,143	0.077	0.828	2.146	.....
Lead sulphide ore shipped	23,713	0.073	4.189	.820	19.974
Lead concentrate shipped	530	0.143	5.432	.729	21.872

During 1912, 12,320 feet of exploration and development work and 664 feet of diamond-drill holes were done, mainly in the following places:

On the 8th level. Driving west on the Highland Boy limestone. The limestone here was siliceous and black, and no ore was found. * * * Work on the Yampa limestone, which overlies and is separated from the Highland Boy limestone by a bed of quartzite. Practically all of the lead ore included in the estimate was found in this territory. * * * Labor troubles greatly interfered with mine operations during the last three and one-half months of the year; and for three weeks, from September 18 to October 9, the mine was completely shut down.

During the operations of the Ohio Copper property [2] for the period from August 1 to December 31, 1912, there were mined and concentrated a total of 234,239 tons of ore, averaging in copper content 1.05 per cent. In the concentrates shipped to the smelter there were 2,343,439 pounds of copper, 1,920.41 ounces of silver, and 379.875 ounces of gold.

[1] Ann. Rept. Utah Consolidated Mining Co. for year ending Dec. 31, 1912.
[2] Ann. Rept. for year ending Dec. 31, 1912.

The group of mines at Bingham operated by the United States Mining Co.[1] were productive of—

57,106 tons of lead ores and 186,165 tons of copper ores. The mines were shut down during part of September and October on account of a strike which affected all * * * the district. At the end of the year operations were again normal. Considerable development work was done during the year, and enough ore was uncovered to maintain the reserve unimpaired.

The United States smelter, situated at Midvale, made very extensive improvements. A new roasting and sintering equipment was installed, which will add to the capacity of the smelter and enable the treatment of an increased amount of sulphide ores. Lead ores carrying a high percentage of sulphur are now being offered on the market in increasing quantities. The smelter is now in a better position to enter the market for the purchase of such ores than it has been in the past. The smelter operated successfully and uninterruptedly through the year. The same is true of the concentrating mill and the Huff Electrostatic Separating plant, both of which are operated in connection with the smelter.

From the Utah Apex mine [2] 34,119 tons of shipping ore and 47,945 tons of milling ore were mined and 15,854 tons of concentrates were shipped. The gross value of ore and concentrates shipped amounted to $635,933 for the metal content of gold, silver, copper, lead, and zinc. The larger part of the milling ores mined were treated at the mill connected with the mine, and some ore mined by lessees was shipped to Midvale for treatment in a custom concentrator, which made a separation of the zinc and lead.

During 1912 the Utah Metal Mining Co.[3] drove its transportation and drainage tunnel 3,657 feet, making a total of 10,586 feet, which has been driven since the commencement. There remains to be—

constructed 908 feet. * * * Since January, 1912, there have been cut several seams of ore varying in thickness from 3 inches to 2 feet. These indicate ore deposits on both sides of the tunnel, as well as above it. Drifting on these veins will be begun later. Early in December, 1912, the tunnel entered the Jordan lime bedding. * * * There are about 800,000 gallons of water daily from the tunnel, in addition to the rights in the flow from the springs in the upper part of Middle Canyon. The company is at present negotiating for the sale of water to adjacent towns and mining companies.

SEVIER COUNTY.

No mining was carried on in the Salina section on account of the bursting of the mountain reservoir, upon which the Lead Hill property depended for its water supply for the 5-stamp concentrating mill. A small lot of lead concentrates, which were produced in 1911, were shipped.

SUMMIT COUNTY.

Fifteen mines situated in the Park City region of this county yielded 217,990 tons of ore in 1912, as against 236,867 tons produced in 1911 by 22 mines. The Park City region comprises the Snake Creek, Uintah, and Blue Ledge districts. The latter did not produce in 1912. Boutwell [4] has described the Park City area in a recent report published by the Survey.

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[1] Ann. Rept. United States Mining Co. for year ending Dec. 31, 1912.
[2] Ann. Rept. for year ending Aug. 31, 1912.
[3] Ann. Rept. for year ending Dec. 31, 1912.
[4] Boutwell, J. M., Geology and ore deposits of the Park City district, Utah, with contributions by L. H. Woolsey: Prof. Paper U. S. Geol. Survey No. 77, 1912, 231 pages.

Number of mines producing and total tons of ore sold or treated in Park City mining region in 1905–1912, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	14	228,142	$306,088	3,998,165	1,254,153	45,280,817	1,972,327	$5,161,192
1906	14	264,792	245,678	3,755,339	1,194,216	46,511,176	3,518,139	5,857,983
1907	15	235,628	173,923	2,794,552	945,722	36,234,757	258,784	4,143,181
1908	11	142,331	105,082	2,463,735	541,061	34,051,699	1,405,652	2,978,518
1909	18	196,172	99,518	2,825,385	1,655,749	46,350,390	6,737,237	4,140,844
1910	16	215,339	92,351	2,571,771	1,423,629	38,129,761	9,437,992	3,849,268
1911	22	296,350	102,204	3,428,651	1,281,190	47,637,642	8,596,564	4,713,236
1912	18	280,671	75,748	3,642,749	1,968,249	42,111,561	8,001,512	5,087,924
Increase (+) or decrease (−) in 1912		−15,679	−26,456	+214,098	+687,059	−5,526,081	−595,152	+374,688

The mine output of the entire district aggregated 280,671 tons, as against a production of 296,350 tons in 1911 and 215,339 tons in 1910. The crude ore shipped directly to smelters consisted of mixed lead carbonates and sulphides and aggregated 32,019 tons, containing 1,656.40 ounces of gold, 1,739,431 ounces of silver, 987,962 pounds of copper, and 15,774,103 pounds of lead, valued in all at $1,976,841, or an average value of $61.73 per ton. The remainder of the ore mined, aside from an important tonnage tested at a gold and silver mill, aggregated 210,971 tons and yielded 51,716 tons of concentrates (including concentrates from 36,012 tons of tailings) containing 2,004.69 ounces of gold, 1,897,191 ounces of silver, 979,696 pounds of copper, 26,335,745 pounds of lead, and 8,001,512 pounds of zinc (spelter), valued in all at $3,107,076, or an average value of $60.08 per ton. In 1911 the average value of the shipping ore was $43.72 per ton, and of concentrate $45.15 per ton.

The Daily West mine [1] in 1912 yielded 11,590 dry tons of first-class ore, all of which was mined from the 1,700-foot level. The milling ore came principally from the same level, amounting to 29,654 tons; the 1,800-foot level produced 13,806 tons, and 1,200 tons came from the deepest or 2,100-foot level. There was less milling ore and more first-class ore mined in 1912 than in 1911. The larger part of the development and exploratory work was performed on the 1,700-foot level and very little on the 2,100-foot level. The quantity of ore delivered to the mill aggregated 44,260 dry tons, from which 1,369 tons of waste were sorted, leaving 42,891 tons, which averaged 8 ounces of silver per ton, and 5.5 per cent of lead, 5.2 per cent of zinc, 3.9 per cent of iron, and 70.4 per cent of silica. From this ore, 7,245 dry tons of lead concentrate and 1,465 tons of zinc concentrate were produced. The assays for crude ore and concentrate are compared in the table following:

Average assay of mill ore, crude ore, and concentrates treated and shipped by the Daly West Mining Co., Utah, in 1912.

Kind of material.	Dry ore.	Gold (per ton).	Silver (per ton).	Copper.	Lead.	Zinc.
	St. tons.	*Fine ozs.*	*Fine ozs.*	*Per cent.*	*Per cent.*	*Per cent.*
Ore treated at mill	42,891	.....	8.00	.....	5.50	5.20
Crude ore shipped	17,497	0.0325	43.24	1.58	17.58	.....
Lead concentrates shipped	7,245	.0358	34.45	1.10	30.84	.....
Zinc concentrates shipped	1,465	.....	20.65	.....	6.22	34.29

[1] Ann. Rept. for year ending Dec. 31, 1912.

The Daly Judge [1] mine yielded 58,951 tons of milling ore and 6,138 tons of shipping ore in 1912. The bulk of the milling ore came from the "back vein" of the 1,200-foot level and the 700-foot level of the Daly vein, which also produced most of the shipping ore. The deepest workings explored were those of the 1,400-foot level of the Daly vein, where only a small quantity of ore was found. The quantity and content of the ore shipped and of products from ore milled were as follows:

Average metallic content of crude ore and concentrates of Daly Judge Mining Co., Utah, in 1912.

Kind of material.	Dry ore.	Gold (per ton).	Silver (per ton).	Lead.	Copper.	Zinc.
	St. tons.	*Fine ozs.*	*Fine ozs.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude ore shipped	3,655	0.045	34.83	19.72	1.75	19.89
Lead concentrates shipped	13,419	.031	32.37	29.71	1.60	15.30
Zinc middlings shipped	5,425	.019	22.58	5.16	.....	40.46

The Ontario mine [2] was operated principally by a lessee on certain portions above the 900-foot level. The fillings from the old stopes were shipped at a small profit to the smelters, but experiments have proven the material will yield its metal content through a process of acid leaching, which is a combination of well-known processes. The mill using the new process was put in operation the latter part of 1912. The mine is under development between the 1,300 and 1,500-foot levels by the Ontario Co.

The Silver King Coalition [3] was the largest producer of lead-silver ore of milling and shipping grade. About one-third of the shipping ore was sulphides. In the western part of the Silver King Coalition holdings of 2,200 acres, the developments had reached such a depth that a 3-compartment shaft was necessary from the Alliance tunnel level, and sinking was begun 8,500 feet from its opening. At this point the collar of the shaft is 1,600 feet from the surface and to reach the ore zone the shaft will be sunk about 1,000 feet. The ore product sold during the year is as follows:

	Dry tons.	Gold.	Silver.	Lead.
		Ounces.	*Ounces.*	*Pounds.*
Crude ore	18,229	1,041	1,175,502	11,376,161
Concentrates	12,485	809	696,154	8,877,543
Total	30,714	1,850	1,871,656	20,253,704

The average assay of the crude shipping lead carbonate and sulphide ore was 0.0571 ounce of gold and 64.48 ounces of silver per ton; and 31.2 per cent of lead. The lead concentrate averaged 0.0648 ounce of gold; 55.76 ounces of silver; and 35.55 per cent of lead.

Lead carbonate ore was found in 1912 in the Thompson-Quincy mine and development was begun from the 900-foot level of the Daly

[1] Ann. Rept. for year ending Dec. 31, 1912.
[2] Ann. Rept. Ontario Silver Mining Co. for year ending Dec. 31, 1912.
[3] Ann. Rept. Silver King Coalition Mines Co. for year ending Apr. 30, 1913.

West mine to open up more of the ore which was encountered on a lower level where water hindered operations.

The Revelator claim was productive of a small quantity of lead-silver ore.

TOOELE COUNTY.

In 1912 the production of 268,605 tons of ore was reported by 32 operators. This was 22,526 tons less than the production of 1911 by 21 operators. The average value of the ore increased from $5.33 in 1911 to $7.07 in 1912. The gold and silver value per ton of this ore was $2.92 in 1912, against $2.51 in 1911. From the ores produced, the content of gold, silver, copper, lead, and zinc was valued at $1,900,365. The production was 21,799.32 ounces of gold, valued at $450,632; 540,861 ounces of silver, valued at $332,630; 1,065,498 pounds of copper, valued at $175,807; 19,025,412 pounds of lead, valued at $856,144; and 1,234,092 pounds of zinc, valued at $85,152. In production of gold the county showed a decrease of $134,285; the silver increased 264,376 ounces in quantity and $186,093 in value. The increase in copper yield was 772,392 pounds in quantity and $139,169 in value, and the increase in lead output was 7,278,615 pounds in quantity and $327,538 in value. The zinc production decreased 3,218,198 pounds in quantity and $168,629 in value. Of the total ore produced in the county in 1912, 164,026 tons were siliceous ores; 19 tons, oxidized copper ores; 101,811 tons, sulphide lead ores; 682 tons, zinc ores, of which the larger part was sulphides; 665 tons, copper-lead ore; and 1,402 tons, lead-zinc carbonate ore. The largest part of the tonnage as given below was treated at gold and silver mills in the Camp Floyd district. The next largest tonnage, 37,740 tons of shipping ore, was sent directly to smelters and yielded $16,381 in gold, 353,657 ounces of silver, 302,273 pounds of copper, 13,939,103 pounds of lead, and 1,234,092 pounds of zinc, having a total value of $996,167, or an average value of $26.40 per ton. Concentrating and jigging mills produced 9,909 tons of concentrates, yielding $1,736 in gold, 121,279 ounces of silver, 474,595 pounds of copper, and 2,029,703 pounds of lead, valued in all at $245,967, or an average value of $24.80 per ton.

Camp Floyd (Mercur) district [1].—Three producers in 1912 reported the treatment, by the cyanide process, of 163,582 tons of ore, which contained $420,687 in gold and 553 ounces of silver, valued in all at $421,027, or an average recovery value of $2.57 per ton. The Consolidated Mercur was the largest producer of gold. The Geyser-Marion property, with mill, was operated by lessees; and the Daisy mine was taken over by a new company, which operated the mine and mill for three months. The total production of district was 163,640 tons of ore, yielding $421,245 of gold and 1,920 ounces of silver, with a total value of $422,426.

The Mercur mine [2] produced in the fiscal year ending June 30, 1912, $494,133.65 in gold, against an output of $545,965 for 1911. From 201,652 tons of ore and re-treated tailings was obtained an average of

[1] Spurr, J. E., Economic geology of the Mercur mining district, Utah: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1895, pp. 349-369.

[2] Ann. Rept. Consolidated Mercur Gold Mines Co. for year ending June 30, 1912.

$2.45 per ton in gold. The tailings discarded contained an average of 82 cents per ton in gold.

If the value of the tailings discarded be added to the value of the gold extracted, the average value per ton of all the material treated during the year will be $3.27. This does not represent the average value of the ore mined, but includes the old tailing re-treated, which constituted 7 per cent of the total tonnage, and which reduced the average value. [In 1911] with 12 per cent of tailing, the average was $3.21. * * * The gold production during the year was 23,931.676 fine ounces. The cost per ounce was, therefore, $20.36. The mint value per ounce is $20.67; hence the profit was 31 cents per ounce. * * * The grand total of the dividends paid out of the properties of the Consolidated Mercur Gold Mines Co. is $3,415,312.97.

North Tintic district.—An important tonnage of oxidized lead ore, zinc, and lead-zinc ore was shipped from the Scranton mine, and lessees of the Bullion group shipped several carloads of oxidized zinc ore. All of the district production was shipped to eastern refineries, with the exception of the straight lead ore, which was purchased by the local smelters.

Ophir district.—In 1912 eleven mines yielded 54,523 tons of ore, which contained $5,725 in gold, 269,887 ounces of silver, 745,525 pounds of copper, 6,279,109 pounds of lead, and 373,870 pounds of zinc, valued in all at $603,073. The Cliff and Hidden Treasure properties contributed the largest part of the tonnage of crude ore, and the Ophir Hill an important lot of concentrates, recovered from ores treated in 1912 and former years. There were 9,909 tons of concentrate and 14,887 tons of crude ore shipped.

The Lion Hill group of mines [1] produced 175 tons of shipping ore assaying 50 ounces of silver and 70 cents in gold per ton. Some of the ore was mined from the Chloride Point property. Ore was also shipped from the Buffalo, Commodore, Eureka-Ophir, Mono, and Selah properties.

Rush Valley district.—The largest part of the material shipped from this district in 1912 consisted of slag from the old Chicago and Waterman slag dumps, and also some tailings from one of the first mills erected. The total quantity of this material shipped aggregated 27,647 tons, and contained 572.17 ounces of gold, 65,372 ounces of silver, 288,630 pounds of copper, and 3,056,606 pounds of lead. The crude ore shipped directly to the smelters aggregated 17,806 tons and contained 569.14 ounces of gold, 196,216 ounces of silver, 31,229 pounds of copper, and 7,914,672 pounds of lead, valued in all at $493,751, or an average of $27.73 per ton. The crude ore in 1911 aggregated 10,107 tons, with an average value of $28.65 per ton. A large number of lessees worked on the old Honerine property and produced an important tonnage of sulphide lead ores carrying some gold and silver and a little copper. Other shipments were made from the Cyclone, Galena King, New Stockton, Quandary, South Fork, and Muerbrook properties.

Silver Islet district.—The output of this district was not important in 1912. The Silver Islet properties were consolidated with the Gethin Le Roy mines, which produced some lead-silver ore.

UINTA COUNTY.

Placers were operated on Green River, and a small production was reported from operations of the Horseshoe placer property.

[1] Annual statement Lion Hill Consolidated Mines for year ending Dec. 31, 1912.

UTAH COUNTY.

The production in 1912 aggregated 38,202 tons, mined by 13 operators. This is 22,407 tons less than was mined by 15 operators in 1911. The total value of the ore, containing gold, silver, copper, lead, and zinc, was $956,058 in 1912, against $1,073,182 in 1911. The total average value per ton of the ore increased from $17.70 in 1911 to $25.03 in 1912, and the gold and silver value from $10.40 to $11.15 per ton.

American Fork district.—Six operators reported the mining of 659 tons of ore, part of which was concentrated. The total output of ore and concentrates contained $2,510 in gold, 11,172 ounces of silver, 3,466 pounds of copper, and 380,630 pounds of lead, valued in all at $27,081, or an average of $41.09 per ton. The output in 1911 aggregated 494 tons of ore with an average value of $49.68 per ton. Shipments of ore were made from the Miller property, with important quantities from the Dutchman, Live Yankee, and Milkmaid, and ore and concentrates were shipped from the Blue Rock property.

The Blue Rock mine [1] yielded 208 tons of ore and jig concentrates, containing 3,614 ounces of silver and 214,019 pounds of lead, with small quantities of gold, copper, and zinc.

Santaquin district.—The Crown Jewel, Chief, and King properties, under one management, are developed by an upper and lower tunnel. The shipments consisted of mixed carbonate and sulphide lead ores, which carried an important quantity of silver and a trace of copper.

Tintic district.—The account of the operations of mines in this district in 1912 is mentioned under Juab County. The producers in Utah County were the Beck Tunnel, Colorado, East Tintic Development, May Day, Sioux, and Yankee. All of the production of the Iron Blossom, which partly extends into Utah County, is included in that of Juab County for the reason that its holdings are largest in that country.

WASATCH COUNTY.

The Park City district, which covers a large part of the area of Summit County, includes producing mines in Wasatch County, the Daly Judge being the principal mine producing, with small quantities of ore from the Revelator and Thompson-Quincy properties, which are mentioned under Summit County.

WASHINGTON COUNTY.

No production of importance was recorded in this county in 1912, but the gold discoveries in the Bull Valley section created interest and several mining companies were prospecting with results reported as encouraging.

[1] Ann. Rept. Pacific Gold Mining & Milling Co. for year ending Dec. 31, 1912.

WASHINGTON.

By C. N. Gerry.

PRODUCTION.

The value of the output of gold, silver, copper, and lead in Washington for the year 1912 was $1,120,214, an increase of only $64,197. During the last three years the totals have changed only slightly in value, although there was a variance in the output of the different metals. The number of operating mines decreased from 60 in 1911 to 46 in 1912.

The output of the State in the last nine years is shown in the following table:

Total tons of ore sold or treated in Washington in 1904–1912, and total content of gold silver, and associated metals.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	54	59,310	$314,463	157,598	350,047	1,760,309	.....	$518,019
1905	51	46,650	405,078	125,376	108,709	605,043	.....	526,200
1906	52	27,133	221,648	45,878	235,030	926,100	.....	350,533
1907	53	44,413	259,074	55,359	297,812	820,035	.....	398,635
1908	64	37,633	242,234	88,823	312,030	1,150,429	.....	378,816
1909	46	36,308	362,051	79,488	255,134	288,700	.....	448,966
1910	76	59,209	788,145	205,345	86,918	1,322,287	.....	968,249
1911	60	82,305	847,677	243,781	318,207	848,584	20,590	1,056,017
1912	46	94,981	680,964	413,538	1,086,010	127,387	.....	1,120,214
Increase (+) or decrease (−) in 1912		+12,676	−166,713	+169,757	+767,803	−721,197	−20,590	+64,197

[a] Includes a small placer production.

ORE PRODUCTION IN 1912.

There was an increase of 12,676 tons in the ore sold or treated, from 82,305 tons in 1911 to 94,981 tons in 1912. This was due almost entirely to shipments of copper ore from Stevens County. The total value of the ore per ton decreased from $12.78 in 1911 to $11.74 in 1912, as a result of treating the low-grade ore at Republic instead of shipping the better grade as in former years. The average value per ton in gold and silver decreased from $11.82 in 1911 to $9.80 in 1912. The greater part of the ore, or 65.36 per cent, was dry or siliceous in character. This included 12,886 tons of iron ore, mostly sulphide, containing 0.04 of an ounce of gold, 0.18 of an ounce of silver, and 2.76 pounds of copper per ton. There were, aside from iron ore, 49,200 tons of siliceous ore, which averaged 0.64 of an ounce of gold and 3.62 ounces of silver. With the exception of 98 tons of silver ore, all of this siliceous ore contained gold and silver, and the value of the gold was greater than that of the silver. The copper ore, or 34.36 per cent of the total, contained 0.02 of an ounce of gold, 6.98 ounces of silver, and 32.18 pounds of copper per ton. Less than 1 per cent was lead ore, assaying 0.01 ounce of gold, 18.57 ounces of silver, 1.28 pounds of copper, and 484.36 pounds of lead per ton. No zinc ore was marketed in 1912.

Output of ore and production of metals in Washington in 1912, by kinds of ore.

Source of production.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.
		Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*
Placers	12	.....	228.71	56	.....	.....
Dry or siliceous ore	27	62,086	32,054.63	180,394	35,606	.....
Copper ore	4	32,632	655.30	228,203	1,050,068	.....
Lead ore	5	263	2.99	4,885	336	127,387
Total	.....	94,981	32,941.63	413,538	1,086,010	127,387

Subdivision of tonnage, by kinds, of ore sold or treated from Washington, in 1912, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan	1,443	.....	.....	1,443
Ferry	53,662	2,101	.....	55,763
King	271	.....	.....	271
Kittitas	33	.....	.....	33
Okanogan	333	18	.....	351
Stevens	6,304	30,513	263	37,080
Whatcom	40	.....	.....	40
Total	62,086	32,632	263	94,981
Average value per ton in gold and silver	$12.46	$4.72	$11.65	$9.80

There were 9 mills in operation in the State in 1912. Of these, 4 were amalgamation plants, 3 were cyanide mills, 1 used amalgamation and cyanide, and 1 straight concentration. A list of mills with equipment was printed in the report for 1911.

The ore treated at gold and silver mills and particularly at cyanide plants increased from 18,844 tons in 1911 to 21,312 tons in 1912. Over one-fourth, or 4,609 tons, was treated by amalgamation and the remainder by cyanidation. Bullion secured by each process is shown in the following table. It was estimated that 36,517 pounds of potassium cyanide and 121 pounds of mercury were consumed in the treatment of this ore. Ferry County greatly increased its bullion output.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Washington in 1912, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Fine ozs.*	*Fine ozs.*	
Chelan	1,443	1,699.41	823	.....	.....	$35,636
Ferry	13,353	.....	.....	5,563.04	30,799	133,939
Kittitas	33	29.80	11	.....	.....	623
Okanogan	257	.....	.....	77.30	89	1,653
Stevens	6,186	197.00	33	197.00	34	8,186
Whatcom	40	10.02	2	.....	.....	208
Total	21,312	1,936.23	869	5,837.34	30,922	180,245

There was a considerable increase in the tonnage of ore concentrated (from 108 tons in 1911 to 7,680 tons in 1912) although several concentration plants were idle.

Mine production of gold, silver, and copper from Washington concentrates in 1912, by counties.

County.	Ore to concentrating mills.	Concentrates produced.[a]				Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	
	Short tons.	*Short tons.*	*Fine ozs.*	*Fine ozs.*	*Pounds.*	
Stevens	7,680	584	8.76	23,360	140,160	$37,673

[a] All copper concentrates.

Over 69 per cent of the ore mined, or 65,989 tons, was shipped without treatment to various smelters. There was a large decrease in siliceous ore shipped directly to smelters and a corresponding increase in copper ore shipped. The first-class siliceous ore shipped to smelting plants represented 61.79 per cent of the ore shipped, or 40,774 tons, and had an average content per ton of $12.31 in gold, 3.64 ounces of silver, and 0.87 pound of copper. The greater portion was a sulphide iron ore in a siliceous gangue shipped for the gold and silver content, but part was a sulphide iron ore shipped as a flux. Copper ore of shipping grade represented 37.82 per cent of the ore shipped, and had an average content of $0.54 in gold, 8.21 ounces of silver, and 36.45 pounds of copper per ton. Nearly all of this ore was sulphide. All the lead ore shipped was sulphide and averaged $0.24 in gold, 18.57 ounces of silver, 1.28 pounds of copper, and 484.36 pounds of lead.

Mine production of gold, silver, copper, and lead from Washington crude ore shipped to smelters in 1912, by counties.

County.	Crude ore to smelter.					Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
Ferry	42,410	23,737.60	121,537	77,968	.....	$578,310
King	271	373.02	2,778	.....	.....	9,419
Okanogan	94	70.29	23,908	966	.....	16,316
Stevens	23,214	749.68	210,108	866,916	127,387	293,488
Total	65,989	24,930.59	358,331	945,850	127,387	897,533
Subdivision by kinds of ore:						
Dry or siliceous	40,774	24,281.04	148,603	35,606	.....	599,200
Copper	24,952	646.55	204,843	909,908	.....	289,479
Lead	263	3.00	4,885	336	127,387	8,854

GOLD.

The production of gold was 32,941.63 ounces, valued at $680,964, in 1912, against 41,006.37 ounces, valued at $847,677, in 1911. The decrease of $166,713 was due to conditions at Republic, where mills were put in operation to treat ore by the cyanide process. More than 97 per cent of the gold came from siliceous ore, largely from Ferry

County. Gold in bullion amounted to $160,694, or 23.60 per cent of the total, and gold in crude ore shipped was valued at $515,362, or 75.68 per cent of the total, leaving only a small amount contained in concentrates and placer output.

Source of gold production in Washington, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan		1,699.41			1,699.41
Clallam	12.39				12.39
Ferry		29,268.81	31.83		29,300.64
King		373.02			373.02
Kittitas	73.77	29.80			103.57
Okanogan	12.14	144.59	3.00		159.73
Snohomish	34.68				34.68
Stevens		528.98	620.47	2.99	1,152.44
Whatcom	95.73	10.02			105.75
Total	228.71	32,054.63	655.30	2.99	32,941.63
Value		$662,628	$13,546	$62	

SILVER.

There was a considerable increase in silver production, from 243,781 ounces, valued at $129,204, in 1911, to 413,538 ounces, valued at $254,326, in 1912. The increase of 169,757 ounces had its source in copper ore shipped. Bullion supplied 31,791 ounces; crude ore shipped, 358,331 ounces; and concentrates, 23,360 ounces. Crude shipping ore still supplies the greater part, or 86.65 per cent of the silver. Siliceous ore, exclusive of iron ore, contained 3.62 ounces of silver per ton, copper ore 6.98 ounces, and lead ore 18.57 ounces.

Source of silver production in Washington, by kinds of ore, in 1912, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan		823			823
Clallam	1				1
Ferry		152,224	112		152,336
King		2,778			2,778
Kittitas	25	11			36
Okanogan	2	23,922	75		23,999
Snohomish	6				6
Stevens		634	228,016	4,885	233,535
Whatcom	22	2			24
Total	56	180,394	228,203	4,885	413,538
Value		$110,942	$140,345	$3,004	

COPPER.

Copper production increased from 318,207 pounds in 1911 to 1,086,010 pounds in 1912, and the improvement in the price per pound increased proportionately, the total value. The greater part of the output came from copper ore mined in Stevens County. Less than 2 per cent was produced from concentrates smelted.

Source of copper production in Washington, by kinds of ore, in 1912, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Ferry	35,582	42,386	.....	77,968
Okanogan	24	942	.....	966
Stevens	.....	1,006,740	336	1,007,076
Total	35,606	1,050,068	336	1,086,010

LEAD.

The lead output decreased from 848,584 pounds, valued at $38,186, in 1911, to 127,387 pounds, valued at $5,732, in 1912. The product came from crude ore shipped from Stevens County.

ZINC.

No ores containing zinc in commercial quantity were marketed, but prospects are good for production from Pend Oreille County.

MINING INDUSTRY IN WASHINGTON IN 1912.

There were two important features which affected the State's mining industry in 1912, aside from the better prices of the various metals. The first was the activity in development in the Chewelah district of Stevens County, as a result of the regular shipments of copper ore from the United Copper property. The completion and initial operation of cyanide mills at Republic, in Ferry County, constituted the second feature of interest. After a year's constant operation it will be easier to see the results of this work.

Mine production of gold, silver, copper, and lead, in Washington in 1912, by counties.

County.	Tonnage.	Gold.		Silver.	
		Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*	
Chelan	1,443	1,699.41	$35,130	823	$506
Clallam	.....	12.39	256	1	1
Ferry	55,763	29,300.64	605,698	152,336	93,687
King	271	373.02	7,711	2,778	1,708
Kittitas	33	103.57	2,141	36	22
Okanogan	351	159.73	3,302	23,999	14,759
Snohomish	.....	34.68	717	6	4
Stevens	37,080	1,152.44	23,823	233,535	143,624
Whatcom	40	105.75	2,186	24	15
Total	94,981	32,941.63	680,964	413,538	254,326

Mine production of gold, silver, copper, and lead, in Washington in 1912, by counties—Continued.

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Chelan					$35,636
Clallam					257
Ferry	77,968	$12,865			712,250
King					9,419
Kittitas					2,163
Okanogan	966	159			18,220
Snohomish					721
Stevens	1,007,076	166,168	127,387	$5,732	339,347
Whatcom					2,201
Total	1,086,010	179,192	127,387	5,732	1,120,214

Tonnage of ore sold or treated, number of deep mines producing, and value of ores in Washington in 1911 and 1912, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1912	Increase (+) or decrease (−).	1911	1912	1911	1912	1911	1912
	Short tons.							
Chelan	1,443	+ 683	3	2	$28.68	$24.69	$28.68	$24.69
Ferry	55,763	+ 1,228	13	12	16.44	12.77	16.07	12.54
King	271	− 210	1	1	27.23	34.76	27.23	34.76
Kittitas	33	+ 10	2	5	33.26	18.88	33.26	18.88
Lewis	.....	− 19	2	.....	23.53	.....	1.00	.....
Okanogan	351	+ 62	3	4	37.56	51.19	37.56	50.74
Pend Oreille	.....	− 51	1	.....	54.88	.....	20.29	.....
Skagit	.....	− 1	1	.....	13.00	.....	.....	.....
Stevens	37,080	+10,934	10	9	4.03	9.15	1.86	4.52
Whatcom	40	+ 40	.....	1	.....	5.20	.....	5.20
Total	94,981	+12,676	36	34	12.78	11.74	11.82	9.80

[a] Value per ton, placer product excluded.

There were only 12 placers operated in 1912, against 24 in 1911. Of these, 4 were worked by drifting and 8 by hydraulic or sluicing methods. There were 34 deep mines, classified as follows: Gold-silver, 21; gold-silver-copper, 6; silver, 2; silver-lead, 3; gold, silver-copper-lead, 1; and gold-silver-lead, 1.

REVIEW BY COUNTIES.

CHELAN COUNTY.

Two deep mines produced 1,443 tons of ore, $35,130 in gold, and 823 ounces of silver, against a production in 1911 of 760 tons of ore, $21,846 in gold, and 480 ounces of silver. The output, which was nearly doubled, was all treated by amalgamation, giving an average recovery of $24.69 per ton in gold and silver.

Blewett district.[1]—Only one property was operated at Blewett and it produced a small quantity of bullion.

[1] Weaver, C. E., Geology and ore deposits of Blewett mining district: Bull. Washington Geol. Survey No. 6, 1911, 101 pp.

Entiat district.—The Wenatchee Gold Mining Co. continued to produce bullion by amalgamation from the Rex mine, and also developed a new property, the Sunset.

CLALLAM COUNTY.

A slight placer output was taken from gravel near Mora.

FERRY COUNTY.

Total tons of ore sold or treated in Ferry County, Wash., in 1905–1912, and total content of gold, silver, and associated metals.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	4	9,540	$86,053	34,945	.....	.....	$107,160
1906	10	6,364	70,742	26,463	52	.....	88,482
1907	5	2,168	4,032	14,321	131,731	.....	39,830
1908	7	722	17,333	7,906	1,144	.....	21,674
1909	9	11,453	210,437	53,694	606	.....	238,439
1910	19	37,874	714,808	185,357	61	128	814,913
1911	13	54,535	778,526	185,239	161,158	.....	896,848
1912	12	55,763	605,698	152,336	77,968	.....	712,250
Increase (+) or decrease (−) in 1912		+1,228	−172,828	−32,903	−83,190	.....	−184,598

There was a slight increase in ore output, but decreases in gold, silver, and copper production. Nearly 59 per cent of the ore and over 63 per cent of the State output in total value came from Ferry County. In value per ton the ore decreased from $16.44 in 1911 to $12.77 in 1912. Twelve mines produced 53,662 tons of siliceous ore and 2,101 tons of copper ore. None of this ore was concentrated, but 13,353 tons were treated in cyanide mills and 42,410 tons were shipped directly to smelters and had a value of $13.64 per ton.

Belcher district.—A sulphide iron ore and some hematite with a small percentage of gold, silver, and copper were shipped from the Belcher mine to be used as a smelting flux.

Danville district.—A low-grade sulphide ore containing gold, silver, and copper was shipped to British Columbia from the Lone Star & Washington property.

Enterprise district.—From the Silver Leaf property a small test shipment of silver ore was made.

Republic district.[1]—Nine mines in 1912 produced 40,775 tons of ore, $594,873 in gold, and 149,752 ounces of silver, against 44,322 tons of ore, $772,874 in gold, and 181,574 ounces of silver in 1911. Of this siliceous ore, 27,442 tons were shipped to smelters, containing 23,313.94 ounces of gold and 118,953 ounces of silver, or an average of $20.26 per ton. The remainder of the ore, 13,353 tons, was treated by the cyanide process and 5,563.04 ounces of gold and 30,799 ounces of silver were recovered, or an average of $10.03 per ton. First-class ore was shipped to Tacoma, Butte, and Canadian plants to be used as converter lining, and milling ore was treated at the San Poil mill

[1] Min. and Sci. Press, Aug. 24, 1912, p. 235; Min. and Eng. World, July 6, 1912, p. 12; Umpleby, J. B., The Republic district, Washington: Bull. Washington Geol. Survey No. 1, 1910, pp. 44–50.

and the plant of the North Washington Power & Reduction Co., both doing custom work. The latter mill treated ore from the Quilp mine and various mines of the Republic Mines Corporation. The last four months of the year one section, which has a capacity of 125 tons, was milling ore averaging $7.75 per ton. The San Poil mill was treating 50 tons per day the last quarter of the year from the Knob Hill and San Poil mines. These plants have been fully described in recent publications.[1]

The largest producer was the Republic Mines Corporation and over two-thirds of its ore was shipped to smelters. According to the fiscal report to stockholders,[2] ending May 31, 1912, the ore shipments for the year aggregated 20,646 tons. The treatment charges were $105,674, the freight was $48,477, and mining, $183,914. The surplus was $42,737 and dividends of $85,000 were declared during the calendar year.

The Knob Hill was operated the entire year, two-thirds of the output smelted and the remainder cyanided.

The Quilp mine was operated by the lessee, the Imperator Quilp Mining Co., producing shipping and milling ore, but in the last part of the year the lease was given up. The owning company declared dividends of $15,000. Shipments were also made from the Ben Hur, Insurgent, and Phil Sheridan mines.

KING COUNTY.

Money Creek or Miller Creek district.—Shipments of gold-silver ore were made from the Apex property, at Berlin, in the northeastern part of the county.

KITTITAS COUNTY.

Swauk district.[3]—Small productions from 5 deep mines and 6 placers at Liberty had a total value in gold and silver of $2,163, a decrease of $667.

OKANOGAN COUNTY.

The output from 1 placer and 4 deep mines was 351 tons of ore, $3,302 in gold, 23,999 ounces of silver, 966 pounds of copper, in all valued at $18,220. Most of the tonnage was siliceous ore, which was milled, and the remainder was copper ore and silver ore, which was smelted.

Cascade or Wauconda district.—Bullion was produced from the Bodie mine.

Myers Creek district.—A small placer output came from the creek bed near Molson.

Nespelem or Moses district.—The Apache and Double Header mines were productive of ore in which the value of the silver was 10 times the value of the gold.

Palmer Mountain district.—A test shipment of copper ore containing gold and silver was made from the Golden Chariot mine.

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[1] Morse, E. C., The San Poil mill, Republic, Wash.: Trans. Am. Inst. Min. Eng., 1912, p. 697. Thomson, F. A., Ore treatment at Republic, Wash.: Trans. Am. Inst. Min. Eng., 1912, p. 672; Min. and Sci. Press, Aug. 24, 1912, p. 235.

[2] Eng. and Min. Jour., Sept. 28, 1912, p. 617.

[3] Smith, G. O., Gold mining in central Washington: Bull. U. S. Geol. Survey No. 213, 1903, pp. 76-80.

PEND OREILLE COUNTY.

Although no ore was shipped from this county, development was in progress and mills are contemplated for the Clark group of the Lead Zinc Co. and the Metaline Oriole Mining Co., both in the Metaline district.[1]

PIERCE COUNTY.

No production was reported from this county during 1912, but the only smelting done in the State was performed at Tacoma. The mining journals have given the changes made in this plant during the year.

At Tacoma[2] the copper smelting plant of the American Smelters Securities Co. is undergoing complete reconstruction. This plant chiefly smelted lead ores until recently, when the growth of the lead smelting industry in Utah and the increased production of copper ores in Alaska have made such extensive changes in the work at Tacoma necessary that it was judged best to entirely rebuild the plant. Since most of the ore at this plant arrives by steamer, unloading and storage facilities are an important feature of the plant construction. New blast furnaces, 42 by 260 inches, are under construction, and accessory apparatus as required. The electrolytic refinery at this plant, the only one in operation west of the Rocky Mountains, is being increased in size from 24,000,000 pounds per year to 36,000,000 pounds per year capacity.

SNOHOMISH COUNTY.

Sultan district.—Only a placer output valued at $721 came from the county.

STEVENS COUNTY.

Total tons of ore sold or treated in Stevens County, Wash., in 1905–1912, and total content of gold, silver, and associated metals.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	10	12,016	$165,863	26,195	15,449	604,843	$212,523
1906	10	12,270	77,837	6,372	72,313	926,100	148,849
1907	12	23,122	149,588	17,100	65,044	820,035	217,348
1908	15	31,863	183,893	53,296	248,432	1,146,929	293,104
1909	11	23,034	121,498	21,571	220,146	288,677	173,747
1910	12	18,473	30,182	13,281	85,063	1,321,871	106,319
1911	10	26,146	27,074	40,664	153,112	836,602	105,412
1912	9	37,080	23,823	233,535	1,007,076	127,387	339,347
Increase (+) or decrease (−) in 1912		+10,934	−3,251	+192,871	+853,964	−709,215	+233,935

Considerable increase was made in silver and copper output. From 9 deep mines 37,080 tons of ore were mined in 1912, against 26,146 tons from 10 properties in 1911. The average value of this ore also increased from $4.03 in 1911 to $9.15 per ton in 1912, and the gold and silver value from $1.86 to $4.52 per ton. Most of the ore, or 23,214 tons, was shipped crude, 7,680 tons were concentrated, and 6,186 tons treated by the amalgamation and cyanide methods. Only 263 tons of lead ore were produced, over 82 per cent of the product being copper ore, which was all sulphide in character.

[1] Bancroft, Howland, Lead and zinc deposits in the Metaline mining district, northeastern Washington: Bull. U. S. Geol. Survey No. 470, 1910, p. 195.
[2] Min. and Sci. Press, Jan. 4, 1913, p. 51.

Bossburg district.—The Bonanza and Young America mines were productive of some lead-sulphide ore shipped to smelters.

Cedar Canyon district.—At Turk only a slight tonnage of lead ore and silver ore was shipped from the Legal Tender and Deer Trail No. 2 properties.

Chewelah district.—From 13,443 tons of ore, $2,077 in gold, 228,747 ounces of silver, 941,833 pounds of copper, and 51,454 pounds of lead were produced, giving a total value of $300,474, or an average value per ton of $22.35. The Blue Star product was lead ore and the United Copper Co.[1] shipped and milled copper ore.

No. 2 tunnel was driven 1,100 feet during the last seven months of the year. * * * Most of our development and nearly all of our efforts during the year have been on No. 2 ore shoot, which we discovered in November, 1911. We drifted 240 feet on 400-foot level and raised 360 feet. * * * For the purpose of commencing permanent development on the 500-foot level a double compartment shaft was sunk to a depth of 145 feet. Before this shaft was started a large hoisting station was established on the 400-foot level, the size of which can best be appreciated by stating that over 20,000 cubic feet of rock was removed at this point. * * * We shipped 5,716 tons of first-class ore, of which the gross value was $207,786.84. * * * From 7,680 tons of ore milled, 407 tons of concentrate and 177 tons of middlings were produced, having a gross value of $33,011. * * * Dividends amounting to $50,000 were declared in 1912.

Colville district.—The Clugston mine, 7 miles east of Bossburg, produced lead-sulphide ore containing considerable silver.

Kettle Falls district.—From the Ben Venue and Sunday Star mines, a few shipments of gold and silver ore were made.

Marcus district.—A large tonnage of low-grade ore was mined from the Napoleon mine, three-fourths of which was a sulphide ore, shipped, and about one-fourth was oxidized ore, milled.

WHATCOM COUNTY.

Slate Creek district.—Tests were made by the Seattle-St. Louis Mining Co. in a 4-stamp amalgamation mill and some placer gold was produced near Bellingham.

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[1] Ann. Rept. United Copper Mining Co. for year ending Dec. 31, 1912

WYOMING.

By Charles W. Henderson.

PRODUCTION.

The total value of the production of gold, silver, and copper in the State of Wyoming in the calendar year 1912 was $26,947, a decrease of $7,460 from that of 1911. The gold yield increased somewhat, but the output of copper and silver decreased. There were 17 producing mines, of which 8 were deep and 9 were placer.

The quantity of ore sold or treated was 2,439 short tons, as compared with 3,491 tons in 1911. The output of siliceous ore increased from 1,447 tons in 1911 to 2,284 tons in 1912, but that of copper ore decreased from 2,044 tons in 1911 to 155 tons. Deep mines yielded $21,469 in gold, 263 fine ounces of silver, and 27,570 pounds of copper. Placer gold production amounted to $766 in 1912, as compared with $7,041 in 1911.

The copper yield, usually of chief importance in this State, represented only 17 per cent of the State total in 1912, gold representing 82½ per cent of the value.

Mine production of gold, silver, and copper in Wyoming in 1911 and 1912.

Year.	Tonnage.	Gold.		Silver.		Copper.		Total value.
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*		
1911	3,491	928.80	$19,200	725	$384	118,584	$14,823	$34,407
1912	2,439	1,075.62	22,235	265	163	27,570	4,549	26,947
Increase (+) or decrease (−)	−1,052	+146.82	+3,035	−460	−221	−91,014	−10,274	−7,460

The following table shows the total output of gold, silver, and copper in Wyoming since 1867:

Production of gold, silver, and copper in Wyoming from 1842 to 1912, inclusive.

Year.	Gold.	Silver.		Copper.		Total value.
	Value.	Fine ounces.	Commercial value.[q]	Pounds.[s]	Value.	
1842–1867	[a] Small unknown.					
1867	[a] $8,600	[o] 70	$90			$8,690
1868	[a] 77,500	[o] 620	802			78,302
1869	[a c] 155,000	[o] 1,240	1,603			156,603
1870	[b c] 155,000	[o] 1,240	1,603			156,603
1871	[c] 155,000	[o] 1,240	1,603			156,603
1872	[d] 100,000	[o] 800	1,034			101,034
1873	[e] 50,000	[o] 400	517			50,517
1874	[f] 25,000	[o] 200	259			25,259
1875	[g] 10,000	[m] 100	124			10,124
1876	[h] 10,000	[m] 100	116			10,116
1877	[h] 10,000	[m] 100	120			10,120
1878	[h] 10,000	[m] 100	115			10,115
1879	[h] 10,000	[m] 100	112			10,112
1880	[i] 20,000	[m] 100	115			20,115
1881	[j] 5,000	[m] 100	113			5,113
1882	[j k] 5,000	[m] 240	274	[u w] 100,000	$19,100	24,374
1883	[j] 4,000	[m] 1,440	1,598	[v w] 962,468	158,807	164,405
1884	[j] 6,000	[m] 100	111			6,111
1885	[l] 10,000	[m] 100	107			10,107
1886	[m] 7,500	[m] 100	99			7,599
1887	[m] 7,500	[m] 100	98			7,598
1888	[m] 7,500	[m] 420	395	[w] 232,819	39,114	47,009
1889	[m] 7,500	[m] 240	226	[w] 100,000	13,500	21,226
1890	[m] 7,500	[m] 100	105			7,605
1891	[m] 7,500	[m] 100	99			7,599
1892	[m] 7,500	[m] 100	87			7,587
1893	[m] 7,500	[m] 100	78			7,578
1894	[m] 7,500	[m] 100	63			7,563
1895	[m] 7,500	[m] 100	65			7,565
1896	[j] 14,300	[j] 100	68			14,368
1897	[j] 11,200	[j] 100	60			11,260
1898	[j] 5,300	[j p] 100	59	[x] 233,044	28,897	34,256
1899	[j] 29,200	[j p] 400	240	[x] 3,104,827	530,925	560,365
1900	[j] 34,200	[j] 200	124	[x] 4,203,776	697,827	732,151
1901	[j] 12,700	[j p] 21,400	12,840	[y] 2,698,712	450,685	476,225
1902	[j] 38,800	[j] 5,000	2,650	[y] 889,228	108,486	149,936
1903	[j] 3,600	[j p] 200	108	[y] 1,023,189	140,177	143,885
1904	[n] 17,305	[n] 4,647	[r] 2,695	[t x] 3,565,629	456,401	476,401
1905	[n] 26,745	[n] 3,655	[r] 2,230	[t y] 2,530,531	394,763	423,738
1906	[n] 6,521	[n] 136	[r] 92	[t z] 106,177	20,492	27,105
1907	[n] 9,344	[n] 3,715	2,452	[t z] 3,026,004	605,201	616,997
1908	[n] 7,959	[n] 3,998	2,119	[aa t] 2,416,197	318,938	329,016
1909	[n] 4,086	[n] 1,754	912	[bb t] 433,672	56,377	61,375
1910	[n] 3,199	[n] 1,478	798	[cc t] 217,127	27,575	31,572
1911	[n] 19,200	[n] 725	384	[dd t] 130,499	16,312	35,896
1912	[n] 22,235	[n] 265	163	[ee t] 25,080	4,138	26,536
Total	1,166,994	57,723	39,725	25,998,979	4,087,715	5,294,434

[a] Raymond, R. W., Mining statistics west of the Rocky Mountains for 1869, 1870. The Sweetwater district, Wyoming, pp. 325–328.

[b] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1870, 1872. Wyoming, pp. 334–335.

[c] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1871, 1873. Wyoming, pp. 372–376.

[d] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1872, 1873. Wyoming, pp. 306–307, see also p. 3.

[e] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1874, 1875, p. 8.

[f] Estimate by Charles W. Henderson. See Raymond, R. W., op. cit., pp. 7–8.

[g] Estimate by Charles W. Henderson. See Raymond, R. W., Mineral resources west of the Rocky Mountains for 1875, 1877, p. 335. "Sweetwater district nearly idle." The total gold for 1867–1875 ($736,100) represents the output of the Sweetwater (Atlantic City, South Pass, Lewiston) district. These figures are much lower than generally quoted. They are the figures of Rossiter W. Raymond, who has explained in his reports herein quoted the manner in which he collected them. The source of the generally quoted figures ($5,050,000) is W. C. Knight (The mining districts in Wyoming: Univ. Wyoming, Agr. Coll. Dept., Bull. No. 14, October, 1893, pp. 123–124), but Knight says: "The only estimate of the output from this region is one which has been generally circulated, but upon what basis the estimate is made or who is the author I am unable to find out." Henry C. Beeler, former State geologist (Mineral resources of Wyoming, State Board of Immigration, Cheyenne, Wyo., 1907, pp. 18–19), says: "The amount of gold produced from 23 properties in this district since its discovery is $3,728,000. The gold from placers in the early

Source of gold and silver production in Wyoming in 1911 and 1912.

Source.	Number of mines.	Ore.	Gold.		Silver.		Total value.
		Quantity.	Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine ozs.*		*Fine ozs.*		
Siliceous ore	3	2,284	1,037.61	$21,449	148	$91	$21,540
Copper ore	5	155	0.95	20	115	71	91
Total deep mines, 1912	8	2,439	1,038.56	21,469	263	162	21,631
Deep mines, 1911	7	3,491	588.19	12,159	515	273	12,432
Increase (+) or decrease (—)	+1	−1,052	+450.37	+9,310	−252	−111	+9,199
Placer mines, 1912	9	.....	37.06	766	2	1	767
Placer mines, 1911	9	.....	340.61	7,041	210	111	7,152
Increase (+) or decrease (—)	.....	.....	−303.55	−6,275	−208	−110	−6,385
Total deep and placer mines, 1912	17	2,439	1,075.62	22,235	265	163	22,398

days of the district * * * can only be estimated and is placed at from $2,000,000 to $3,000,000;" and (on p. 3) he adds: "Gold mines were first worked at South Pass, Fremont County, in 1867, since which date the industry has amounted to something each year. The annual production has fluctuated from $25,000 to $125,000, the total being estimated at $4,000,000." Mr. Beeler (oral communication) says these figures are borne out by statements of some of the old residents of this district, including stage drivers, bankers, etc. C. E. Jamison, State geologist (Geology and mineral resources of a portion of Fremont County, Wyo., Bull. No. 2, series B, Cheyenne, 1911, p. 80), gives "estimated output of the mines of the South Pass district as $5,863,000."

The earliest report at hand is that of Samuel Aughey (Ann. Rept. Territorial geologist to the governor of Wyoming, January, 1886, Laramie, Wyo., 1886, pp. 12–15), who says: "Placer grounds on Spring Gulch, at Miner's Delight, are still successfully worked every spring while the water lasts. Up to date these grounds have yielded over $400,000 in gold. The Miner's Delight * * * when worked in the palmy days of mining * * * produced at least $200,000."

Other publications reviewed are as follows:

Warren, F. E., Rept. Governor of Wyoming to the Secretary of the Interior, 1885, Government Printing Office, 1885, p. 1148.

Ricketts, L. D., Ann. Rept. Terr. Geologist to the Governor of Wyoming, 1888, pp. 60–72; idem, 1890, pp. 73–78.

Beeler, H. C. (State geologist), A brief review of the South Pass gold district, Fremont County, Wyo., Nov. 1, 1908, 18 pp.

h Estimate by Charles W. Henderson. Based on opening of placers in Wyoming adjacent to Black Hills, S. Dak.

i Burchard, H. C., Rept. Director Mint for fiscal year 1880, 1881, p. 8.

j Mineral resources U. S., U. S. Geol. Survey. Estimate of the Director of the Mint.

k See Burchard, Rept. Director Mint, p. 594.

l Estimate by Charles W. Henderson, partly by elimination of production of other States.

m Estimate by Charles W. Henderson.

n Mineral resources U. S., U. S. Geol. Survey. Collected by the U. S. Geological Survey from the mines.

o Estimated on basis of fineness of gold and silver, Sweetwater district.

p A knowledge of the quantity of silver in the copper ore of the Encampment district shows that the figures for silver are too low for 1898, 1899, 1900, and 1903, the figures are too high for 1901.

q Except for the period 1867–1874, inclusive, when coining value ($1.2929) was approximately commercial value.

r Previous figures of the U. S. Geological Survey are, respectively, $2,661, $2,208, and $91.

s From Copper, Mineral Resources United States, U. S. Geological Survey, being copper output as reported from smelters and refineries.

t The copper output as reported by the mines to the Survey for the years 1904–1912 is—

	Pounds.		Pounds.
1904	3,527,008	1910	222,339
1905	2,394,008	1911	118,584
1906	24,000	1912	27,570
1907	2,257,650		
1908	2,452,049	Total	11,515,747
1909	492,539		

The smelter figures are 12,450,916 pounds.

u See Kirchhoff, C., jr., The copper industry of the United States: Mineral resources U. S. for 1881–82, U. S. Geol. Survey, 1883, p. 216 (for output), p. 229 (for history of discovery of copper in the State).

v For figures see op. cit. for 1883–84, U. S. Geol. Survey 1885, p. 329.

w From Hartville district, Laramie County.

x From Encampment district, Carbon County, showing beginning in 1898.

y From Encampment district and Douglas Creek (Holmes, New Rambler) district (in Albany County adjoining), showing beginning of output of New Rambler property

z Encampment, Douglas Creek, Hartville, Copper Mountain.

aa Encampment, Hartville, Copper Mountain.

bb Encampment and Hartville.

cc Douglas Creek and Copper Mountain.

dd Encampment, Douglas Creek, and Hartville.

ee Douglas Creek and Hartville.

MINING INDUSTRY IN WYOMING IN 1912.

The principal producing mining district in Wyoming in 1912 was the Atlantic City (or South Pass) district, Fremont County, with output in bullion, cyanide precipitates, crude ore, and placer bullion. Copper ore was shipped from Holmes, Carbon County, and from Hartville, Laramie County. A small quantity of placer gold was also recovered in Hurricane district, Crook County.

List of reduction mills in Wyoming in 1912.

Name.	District.	Process.	Equipment.	Approximate maximum capacity per day.
				Short tons.
Albany County:				
Rambler [a]	Douglas Creek	Concentration	1 crusher, 3 rolls, 5 Wilfley and 1 Deister table, home-construction classifiers. To be remodeled in 1913.	75
Fram [b]	La Plata	Amalgamation	250-pound stamps, 2; 16-foot arrastre, stone mill, Hungarian and home-made riffles.	1
Carbon County:				
Penn-Wyoming [a]	Encampment	Concentration	Blake crusher, elevator, revolving screens, roughing rolls, 2 Hancock jigs, capacity 700 tons per day, rolls, 12 No. 5 Wilfley tables, and slime treatment equipment. [c]	1,000
Crook County:				
Reuter No. 1 [d]	Bear Lodge	Cyanidation	5-foot Huntington mill, 10 by 5 feet percolation tank, 2 Gates crushers.	30
Bock [d]	do	Amalgamation and cyanidation.	1 Gates crusher, 5 stamps, 950 pounds each. Cyanide tanks to be added.	25
Fremont County:				
Duncan [b] (Beck.)	Atlantic	do	1 Blake crusher, 4 Nissen crushers, 1 Akins classifier, 2 cones, 5-foot Wheeler type pan tube mill, 4 cyanidation tanks, 3 Dorr thickeners, cyanidation by agitation and decantation, 1 mechanical agitation tank, 1 sand filter tank. Cyanide annex completed November, 1912.	50
Barr [a]	do	Amalgamation	5-foot Huntington mill, 10 stamps	25
Carissa [a]	do	Amalgamation and concentration.	10 crushers, 850 pounds each, 1 Frue vanner, 10 stamps. Used chiefly as a test plant.	20
Hidden Hand [b]	do	Amalgamation	Crusher, pulverizer, and iron arrastre	½
Mary Ellen [d]	do	do	Denver quartz mill. Purchased Helen G. mill and moved to Mary Ellen property. Plan cyanide installation.	96
Miners Delight [a]	do	Amalgamation and concentration.	10 stamps	25
Neff [a]	do	Amalgamation	do	10–30
Johnson County:				
Kelly Creek [a]	Buffalo	do	5 stamps, Pierce riffles	10

[a] Idle 1912.
[b] Operated 1912.
[c] Beeler, H. C., Mineral Resources of Wyoming, the State Board of Immigration, Cheyenne, Wyo., 1907, p. 23.
[d] Building 1912.

Of the 13 mills in Wyoming 3 were operated in 1912, 3 were building, and 7 were idle. There were 70 pounds of quicksilver and 600 pounds of potassium cyanide used in Wyoming mills in 1912.

REVIEW BY COUNTIES.

ALBANY COUNTY.

The Rambler [1] property, at Holmes, was again the only important producing mine in Albany County, but the output was less than in 1911. Two cars of copper ore, carrying platinum and palladium, as well as small quantities of gold and silver, were shipped to Omaha. Payment was made for the platinum and palladium on a basis of 60 per cent of the market value. The mill on the property was not operated in 1912, and will be remodeled before being operated again. Several tons of ore were shipped to Denver from the Fram mine, near Centennial.

The following table shows the production of Albany County for those years for which figures are available:

Production of gold, silver, and copper in Albany County,[a] Wyo., 1868–1912.

Year.	Tonnage.	Gold.		Silver.	Copper.
		Placer.	Deep mines.		
	Short tons.			*Fine ounces.*	*Pounds.*
1868–1893		[b] $40,000	[b] $189,000		
1901–1912		[c] 945			
1901–1903					[c] 900,532
1907					[c d] 24,350
1909–1912	[c e] 3,071		[c] 2,108	[b] 3,213	[c] 700,567
Total					1,625,449

[a] Chiefly Douglas Creek district.
[b] Knight, W. C., The mining districts of Albany County: University of Wyoming, Agri. College Dept., Bull. No. 14, October, 1893, p. 128. (Probably too high, considering total production of Wyoming for these years.)
[c] Mineral Resources records.
[d] Beeler, H. C., Mineral Resources of Wyoming, State Board of Immigration, Cheyenne, Wyo., 1907, p. 27, gives 828,700 pounds for production of the Rambler mine to date (1907).
[e] For one year tonnage of concentrates used instead of crude ore, giving therefore tonnage and contents of material smelted. The concentrates were little better than the original crude ore.

CARBON COUNTY.

Sluicing for 60 days at the Purgatory Gulch placer, near Encampment, resulted in a very small yield of placer gold, and operations ceased. Some assessment and development work was done on lode mines in the county, but most of the properties were inactive.

The Penn-Wyoming mines and smelter, near Encampment,[2] from which much of the copper output from Wyoming has come, were idle.

The following table shows the production of the Encampment district from the year of first output, 1898, to 1912:

[1] Emmons, S. F., Platinum in copper ores in Wyoming: Bull. U. S. Geol. Survey No. 213, 1903, pp. 94–917
Kemp, J. F., Platinum in the Rambler mine, Wyoming: Mineral Resources U. S. for 1902, U. S. Geol. Survey, 1904, pp. 244–250.
Platinum in Wyoming: Eng. and Min. Jour., March 4, 1911, p. 460. Concentration o platiniferous copper ore at the Rambler mine, Wyo.: Metall. and Chem. Eng., February, 1911, pp. 75–78.

[2] Spencer, A. C., Mineral Resources of the Encampment copper region, Wyoming: Bull. U. S. Geol. Survey No. 213, 1903, pp. 158–162.
Spencer, A. C., Copper deposits of the Encampment district, Wyoming: Prof. Paper U. S. Geol. Survey No. 25, 1904, 107 pages.
See also Spencer, A. C., Reconnaissance examination of the copper deposits at Pearl, Colo.: Bull. U. S. Geol. Survey No. 213, 1903, pp. 163–169.

Production of gold, silver, and copper in the Encampment[a] district, Carbon County, Wyo., from 1898 to 1912.

Year.	Tonnage.	Gold.	Silver.		Copper.		Total value.
			Fine ounces.	Commercial value.	Pounds.	Value.	
	Short tons.						
1898	[b] 2,484	[b] $497	[b] 314	$185	[c] 233,044	$28,897	$29,579
1899	[b] 33,095	[b] 6,619	[b] 4,183	2,510	[c] 3,104,827	530,925	540,054
1900	[b] 44,808	[b] 8,962	[b] 5,663	3,511	[c] 4,203,776	697,827	710,300
1901	[b] 28,766	[b] 5,753	[b] 3,636	2,182	[cd] 2,698,712	450,685	458,620
1902	[b] 2,536	[b] 507	[b] 321	170	[c d] 237,892	29,023	29,700
1903	[b] 8,250	[b] 1,650	[b] 1,043	563	[c] 773,993	106,037	108,250
1904	41,370	6,593	4,483	2,600	[e] 3,527,008	451,457	460,650
1905	28,039	4,678	3,549	2,165	[e] 2,385,628	372,158	379,001
1906	60	.....	.....	.....	[c] 24,000	4,632	4,632
1907	25,950	4,802	2,982	1,968	[e] 2,206,065	441,213	447,983
1908	18,851	6,181	3,123	1,655	[e] 2,367,666	312,532	320,368
1909	150	.....	.....	.....	[e] 33,431	4,346	4,346
1910	.....	.....	.....	.....	.....	.....	.....
1911	20	.....	21	11	[e] 4,738	592	603
1912	.....	[f]	.....	.....	.....	.....	.....
Total	234,379	46,242	29,318	17,520	21,800,780	3,430,324	3,494,086
Average per ton	.....	$0.197	0.125 ounce.	.....	93 pounds, or 4.65 per cent.	.....	.....

[a] Including various small yields from other districts of Carbon County (being the output of Carbon County).
[b] Estimated by Charles W. Henderson.
[c] Smelter figures.
[d] The Encampment production for 1901–2 is the total Wyoming copper production less the Douglas Creek, Albany County, copper production. The Douglas Creek figures are available only for the two years combined. This combined production has been subtracted from the total Wyoming production for 1902, none being subtracted from the 1901 figures. In either event, the total pounds of copper produced in each camp would be unchanged.
[e] Mine figures.
[f] Small, insignificant placer output.

CONVERSE COUNTY.

At the Saul's Camp mine, near Esterbrook, developing and prospecting work was done by shafts and by diamond and churn drilling, and some copper-sulphide ore, carrying also gold and silver, was stored. Development work was also done on the Cornelius-Kreisler prospect, in the same district.

CROOK COUNTY.

Sluicing in the Hurricane district, northwest of Tinton, S. Dak., resulted in a small placer output.

There was some development work and two small amalgamation and cyanide mills were under construction in the Bear Lodge district,[1] near Sundance, but no output was made.

FREMONT COUNTY.

From 2 deep mines and 4 placers in the Atlantic City district, and including a small yield from a dredge on Willow Creek, there was a production in Fremont County of $21,804 in gold and 146 ounces of silver, valued at $90, as compared with $18,672 in gold and $161 in silver for 1911, and compared with a total value of $1,786 in 1910 for the county.

Atlantic City (South Pass) district.—Almost all the gold output and over one-half the silver output of the State was from this district,

[1] Darton, N. H., Sundance folio (No. 127), Geol. Atlas U. S., U. S. Geol. Survey, 1905.

where there has been during 1911–12 a reopening of the mines of the old Sweetwater district of 1867–1877. At the Duncan mine the ore was both amalgamated and cyanided. A small shipment of very high-grade ore was made from the Hidden Hand mine, at Lewiston. A small quantity of placer gold was recovered during the year. The X. L. Gold Dredging Co. completed its preparation for hydraulicking.

Copper Mountain district.—A little development work was done in this district in 1912.

Dredges on Bighorn River and tributaries.—The Shoshoni Gold Dredging Co.'s Marion dredge of 61 buckets, on Bighorn River, near Shoshone, after a short trial run, was closed down, and operations were discontinued.

JOHNSON COUNTY.

Some development work was done in the Bull Camp district of Johnson County, southwest of Buffalo.

LARAMIE COUNTY.

Several cars of copper ore were shipped to Omaha from the Green Hope, Michigan, and other properties in the Hartville district.[1]

The following table shows the production of the Hartville district since its discovery in 1881:

Production of the Hartville[a] district, Laramie County, Wyo., from 1882 to 1912.

Year.	Tonnage.	Silver.		Copper.		Total value.
		Fine ounces.	Commercial value.	Pounds.	Value.	
	Short tons.					
1882		[b] 140	$160	100,000	$19,100	$19,260
1883		[b] 1,340	1,487	962,468	158,807	160,294
1888		[b] 320	301	232,819	39,114	39,415
1889		[b] 140	132	100,000	13,500	13,632
1882–1889	[c] 4,651	[b] 1,940	2,080	1,395,287	230,521	232,601
1907–1909, 1911–1912	[d] 539	[e] 342	188	172,875	23,127	23,315
Total	5,190	4,282	2,268	1,568,162	253,648	255,916

[a] For basis of figures, see Kirchhoff, C., jr., The copper industry of the United States: Mineral Resources for 1881–82, U. S. Geol. Survey, 1883, pp. 216, 229; idem for 1883–84, U. S. Geol. Survey, 1885, p. 329. Knight, W. C., The Hartville district: Bull. Univ. Wyoming, Agr. Coll. Dept. No. 14, October, 1893, pp. 135–136.

[b] Estimated by Charles W. Henderson on Mr. Kirchhoff's statement that ore contained ⅛ to ½ ounce of gold for every per cent of copper.

[c] Estimated on basis of 15 per cent copper per ton (Kirchhoff).

[d] Mineral Resources records, collected from the mines.

[e] Mineral Resources records 1911–12. Estimated on 1911–12 record for 1907, 1908, 1909.

PARK COUNTY.

A little development work was done in the Sunlight and Wood River districts, Park County.

UINTA COUNTY.[2]

There was no production in Uinta County in 1912.

[1] Smith, W. S. T., Hartville folio (No. 91), Geol. Atlas U. S., U. S. Geol. Survey, 1903.
Ball, S. H., Copper deposits of the Hartville uplift, Wyoming: Bull. U. S. Geol. Survey No. 315, 1907, pp. 93–107.

[2] Schultz, A. R., Gold developments in central Uinta County, Wyo., and at other points on Snake River: Bull. U. S. Geol. Survey No. 315, 1907, pp. 71–88.

QUICKSILVER.

By H. D. McCaskey.

INTRODUCTION.

Preliminary figures on the domestic production of quicksilver in 1912 were published by the United States Geological Survey on January 10, 1913. These figures, compiled from earliest possible data for the output of the first 11 months of the year and estimates for December, gave a production for the United States for 1912 of 25,147 flasks, of 75 pounds each, valued, at the average San Francisco domestic price, at $1,057,180. Of this output 20,613 flasks were assigned to California and 4,534 flasks to Nevada and Texas combined.

Final and revised figures of the United States Geological Survey give a domestic production of quicksilver of 25,064 flasks, valued at $1,053,741, of which 20,524 flasks were produced in California and 4,540 flasks were produced in Nevada and Texas combined. The total error in estimate for the new year's figures was therefore only 0.3 per cent, and the credit for this must be given chiefly to the producers, who, without exception, promptly, courteously, and accurately gave their early figures and estimates to the Survey.

CONDITION OF THE INDUSTRY.

Owing to the generally low prices prevailing, the domestic quicksilver industry was not particularly prosperous in 1912. The great majority of the producers are operating old mines in which high-grade ore is now rarely encountered, and there were no new rich ore shoots reported for the year. In most cases special skill is required to prevent the plants from running at a loss. It is probable that under the most favorable conditions, even with the low prices of 1912, large supplies of rich ore would have resulted in substantial profit, but such supplies are no longer reported and it is questioned whether they exist. Although each well-developed property is equipped with its own plant and presumably run at lowest costs, the margin of profit in many cases is so small upon low-grade ores that during periods of low prices the mining activity is likely to be considerably curtailed. Conversely, during high prices it may pay to search the mine more thoroughly for all ore of whatever grade. It is true that further improvements in metallurgical treatment, particularly in preventing furnace losses, should result in a better margin of profit.

But little improvement can be made with low market prices and uncertainty of ore supplies. The domestic market for quicksilver appears to demand from 20,000 to 25,000 flasks for consumption per annum. The foreign market is not profitable to American producers in competition with large European supplies available at lower prices. At low prices and normal output there is little importation, but at high prices importation of foreign supplies reacts to curtail output by cutting prices to a low margin of profit. It would seem, therefore, that unless rich ore, workable under favorable conditions at large profit, be available, or industrial chemistry find new uses for the metal and an increase in domestic demand results thereby, the present producers must continue to operate under somewhat unfavorable conditions, and new producers and small mines must compete with established mines and plants now operated presumably at minimum costs and with special skill and knowledge of the art. The quicksilver trade was generally quiet in 1912. Details of uses, production, prices, etc., follow.

USES OF QUICKSILVER.

Quicksilver is used mainly in the manufacture of fulminate for explosive caps, of drugs, of electric lighting and scientific apparatus, and in the recovery of the precious metals, especially of gold, by amalgamation. An increasing demand has been reported in manufactures of electric appliances. An interesting and increasing use in Scotland is the floating of the lights of lighthouses upon a body of quicksilver. The metal is not consumed, of course, after installation and the loss in use is insignificant. Concerning this Consul Fleming[1] writes as follows:

> The principal uses of quicksilver in Edinburgh are for resilvering mirrors and for "floating" the revolving lights in lighthouses. The commissioners of northern lighthouses, Edinburgh, have in their charge 90 lighthouses on the coast of Scotland. Up to the year 1900 the revolving lights were borne on rollers. The "float" system has been gradually introduced, however, and is now in operation at 30 coast stations and will be used at all others. The lighting machinery rests on a pontoon which runs on quicksilver in a groove. The quantity of mercury required for this purpose in a lighthouse is from 7 to 8 flasks of 75 pounds each. As the waste is trifling, the total present demand for this purpose is small.

Some conflict of opinion exists as to the quantity of quicksilver now consumed in silvering mirrors. The best information indicates that the metal is now rarely used for this purpose, having been almost entirely superseded by nitrate of silver. On this point Consul Halstead[2] writes as follows:

> According to the largest manufacturer of looking glass, etc., in the United Kingdom, there has been no quicksilver used in mirrors in the Birmingham district for the past quarter of a century. In fact, it has been reliably reported that not a single ounce of quicksilver is used for this purpose in the entire United Kindgom. A large amount of "silvering" is done, but for this purpose nitrate of silver is used.

Another use of quicksilver, for which an important expansion in the future is suggested, is that of painting ships' bottoms to keep

[1] Fleming, Rufus, consul, Edinburgh, Scotland, June 27, 1911, Report to State Dept., Washington, D. C.
[2] Halstead, Albert, consul, Birmingham, England, June 15, 1911, Report to State Dept., Washington, D. C.

them free of organic growth. Such use is reported by Consul Metcalf[1] from the important shipbuilding district of Newcastle-on-Tyne:

> The uses of quicksilver at Newcastle-on-Tyne are in the manufacture of chemicals and drugs and for coating ships' bottoms. In this last-named use quicksilver is mixed with an oxide in the manufacture of a composition for painting ships' bottoms, and is considered very valuable as a poison for preventing the growth of barnacles, etc.

Finally, there have been indefinite reports of extensive experiments with the view to utilization of quicksilver in electrical appliances and for protective coating of iron from oxidation. Concerning this last is the report of Vice Consul General William Dawson, jr., at Frankfort, Germany,[2] quoted from the Frankfurter Zeitung:

> In order to protect iron objects from rust it is customary to coat them with zinc, either electrolytically or by plunging them into a bath of melted zinc after careful cleansing. The disadvantage of these two methods is that a real fusion of the two metals is not obtained. As a result, the zinc coating is likely to be attacked by the atmosphere.
>
> This may be avoided by a recently patented process, which consists in so preparing the iron that the zinc gets into its pores. After steeping in sulphuric acid the iron is placed in a solution of mercury chloride and then heated, resulting in a decomposition of the mercury chloride and precipitation of metallic mercury, which forms an amalgam of iron on the surface. The iron is then plunged into a zinc bath heated to 500°, where it remains three minutes.
>
> Iron galvanized by this process usually shows strong adhesion of coating to metal. Microscopic investigation shows that the zinc penetrates into the pores of the iron, and in case a portion of the coating is worn or broken off iron does not rust, owing to the presence of sufficient zinc in the pores.

PRODUCTION.

NUMBER OF MINES, METAL OUTPUT, AND VALUE.

In 1912 there were altogether 20 mines and prospects producing quicksilver in the United States, against 25 in 1911 and 19 in 1910. In all three years, also, there were a few mines producing ore but no metal, and a few producing metal from ore mined in previous years. Seventeen of the producing mines reporting in 1912 were in California and three in Nevada and Texas. As in 1911 and 1910, no output was reported from Arizona, Oregon, Utah, Washington, or other States.

According to confidential returns to the Survey from every producing district, the output of quicksilver in the United States in 1912 was 25,064 flasks of 75 pounds each. At the average domestic price per flask at San Francisco for the year of $42.05, this production was valued at $1,053,941. Compared with figures for 1911 and 1910, the yield of 1912 showed an increase of 3,808 flasks in quantity and of $75,952 in value over the production of 1911, and of 4,463 flasks and $95,788 over the production of 1910. The production of California increased from 17,211 flasks, valued at $800,484, in 1910 to 18,860 flasks, valued at $867,749, in 1911, and to 20,524 flasks, valued at $863,034, in 1912. The output of Nevada and Texas combined decreased from 3,390 flasks, valued at $157,669, in 1910, to 2,396 flasks, valued at $110,240, in 1911, but increased to 4,540 flasks, valued at $190,907, in 1912.

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[1] Metcalf, Horace W., consul, Newcastle-on-Tyne, England, July 18, 1911, Report to State Dept., Washington, D. C.

[2] Daily Cons. and Trade Repts., Dept. Commerce, Sept. 23, 1912, p. 1519.

The following table shows the production for 1910, 1911, and 1912:

Production of quicksilver in the United States in 1910, 1911, and 1912, by States, in flasks of 75 pounds.

State.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	17,211	$800,484	18,860	$867,749	20,524	$863,034
Nevada and Texas	3,390	157,669	2,396	110,240	4,540	190,907
Total	20,601	958,153	21,256	977,989	25,064	1,053,941

There is, in addition to production from ore and furnace material (soot and other cleanings) given above, an annual output of secondary quicksilver from clean-ups of old gold and silver amalgamation mills as on the Comstock, in Colorado, and elsewhere. This source of supply tends to reduce the market for new metal somewhat, but only to a small degree. Figures for output of secondary quicksilver are incomplete.

PRODUCTION OF QUICKSILVER, 1902–1912.

The production of quicksilver in the United States for the period 1902–1912 is shown in the following table:

Production of quicksilver in the United States from 1902 to 1912, inclusive, in flasks.[a]

Year.	Arizona.	California.	Nevada.	Oregon.	Texas.	Utah.	Total.
1902	.....	28,972	.....	.....	5,319	.....	34,291
1903	.....	30,526	65	.....	5,029	14	35,634
1904	.....	29,217	17	.....	5,336	745	35,315
1905	.....	24,635	.....	43	4,723	1,133	30,534
1906	.....	20,310	.....	3	4,761	1,009	26,083
1907	.....	17,431	.....	.....	3,686	437	21,554
1908	(b)	16,984	.....	[c] 386	2,382	.....	19,752
1909	.....	16,078	[c] 809	(c)	4,188	.....	21,075
1910	.....	17,211	70	.....	3,320	.....	20,601
1911	.....	18,860	(d)	.....	[d] 2,396	.....	21,256
1912	.....	20,524	(d)	.....	[d] 4,540	.....	25,064
Total	.....	240,748	961	432	45,680	3,338	291,159

[a] 76½ pounds net for 1902, 1903, and 5 months of 1904; 75 pounds since June 1, 1904.
[b] Arizona and Oregon combined for 1908.
[c] Nevada and Oregon combined for 1909.
[d] Nevada and Texas combined for 1911 and 1912.

In the table the figures for Utah, as first furnished the Survey and published in previous volumes of Mineral Resources, are in part corrected by latest information.

The average total annual output for the period was 26,469 flasks, and for California 21,886 flasks. The yields for the United States and for California in 1912 were therefore slightly below the average. For the period it is to be noted that California supplied 240,748 flasks, or 82.7 per cent of the total domestic production. Until Texas began production in 1899 California supplied practically the entire production of the United States for the half century dating back to the earliest recorded output in 1850.

TONNAGE AND RECOVERY.

Producers reported 166,564 short tons of new ore mined and available for treatment in 1912, against 143,582 tons in 1911, of which 155,693 tons were treated in 1912, against 138,525 tons in 1911. The average recovery in 1912 was 12.1 pounds of metal per ton, or 0.605 per cent of the ore treated, against 11.5 pounds, or 0.575 per cent, in 1911, and 12.5 pounds, or 0.625 per cent, in 1910.

In California 139,347 short tons were treated, against 130,926 tons in 1911, with an average of 11 pounds of metal recovered per ton treated, or of 0.55 per cent of the ore, against a recovery of 10.8 pounds, or 0.54 per cent of the ore, in 1911. In Texas and Nevada combined 16,346 short tons were treated in 1912, against 7,599 tons in 1911, with an average recovery of 20.8 pounds per ton, or 1.04 per cent, against 23.6 pounds, or 1.18 per cent, in 1911.

The following table gives the tonnage treated and the recoveries, by States, for 1911 and 1912:

Quicksilver ore treated and average recoveries, by States, in 1911 and 1912.

State.	1911			1912		
	Short tons treated.	Pounds of metal recovered per ton.	Percentage of ore recovered as metal.	Short tons treated.	Pounds of metal recovered per ton.	Percentage of ore recovered as metal.
California	130,926	10.8	0.54	139,347	11.0	0.55
Nevada and Texas	7,599	23.6	1.18	16,346	20.8	1.04
Total and average for United States	138,525	11.5	0.575	155,693	12.1	0.605

During the last two years inquiries have been made by the Survey relative to methods of recovery, and quantitative data on the subject have become available for the first time. These data show the insignificant total output from retorts, although a large number of retorts usually are in operation.

Quicksilver retort furnaces are of two types: The pipe retort and the D retort. Both work on the principle of distilling off the mercury from the ore separately from the gases of combustion and conveying the volatilized metal through short outside condensing pipes to a trough in which the mercury is collected. The retorts are built over fire boxes and are filled and discharged horizontally from the same doors and from the furnace floor, the D retort by means of iron pans resting on the flat bottom and the pipe retort by semicircular shovels and hoes. Retort plants contain from 1 to 15 retorts, 12 being the usual number for a pipe-retort plant, and are inexpensive to build and operate. It has been estimated[1] that a 12-pipe plant costs from $1,000 to $1,500, depending upon local conditions. The pipes themselves cost $25 to $35 apiece, whereas the D retorts cost about $250 each. The D retort, however, increases capacity and

[1] Booth, Frank J., The reduction of quicksilver ore: Min. and Sci. Press, Nov. 10, 1906.

decreases space. Recovery is probably about 75 per cent of metal in the ore as charged. Retort plants serve useful purposes at small mines or in prospecting or early development, but are best used perhaps for treatment of rich ore and concentrates or furnace soot. Unless carefully operated they menace the health of workmen by causing salivation; and when in operation at new mines the temptation is to gouge out rich ore for them and possibly quickly to sacrifice a property that otherwise might be remunerative if worked on a larger scale and by better methods.

The great bulk of present domestic output is from shaft furnaces, in which, as is well known, the descending ore meets the upward furnace flames and gases, and the volatilized metal passes with the gases and impurities of combustion into a series of condenser chambers, usually of brick, in which the metal is collected and from which it is drawn off. The gases pass from the final chamber to the stack, usually through an inclined flue. The modern tendency is toward the increased use of the Hüttner tile furnace perfected by Robert Scott, formerly of the new Almaden mine, which is adapted to both medium and fine ore. All the furnaces in Texas and Nevada are of this type. At New Idria, also, are the coarse ore furnaces designed by B. M. Newcombe, the well-known manager, and at the Guadalupe are the Davey modified Litchfield furnaces. Some thought and experimentation have recently been given to the application of rotary furnaces for quicksilver ores. It has been estimated that a Scott furnace can be built, under favorable local conditions, at about $1,000 per ton of capacity. According to this the common 10-ton furnace should cost about $10,000.

The following table shows the tonnage treated in retorts and in furnaces in 1912 and the recovery of metal in each type:

Quicksilver ore treated in retorts and in furnaces in 1912, by States.

State.	Ore treated, short tons.		Quicksilver recovered, flasks.		Percentage of metal recovered per ton of ore treated	
	Retorts.	Furnaces.	Retorts.	Furnaces.	Retorts.	Furnaces.
California	1,056	138,291	426	20,098	1.04	0.54
Nevada and Texas	1	16,345	3	4,537	11.25	1.04
Total United States	1,057	154,636	429	24,635	1.52	0.60

On comparing these figures with those of the tables preceding, it will be found that 99.3 per cent of the quicksilver ore treated in the United States in 1912 was originally supplied to shaft furnaces and produced 98.3 per cent of the total quicksilver recovered. The corresponding figures for 1911 were 99.8 and 99.2 per cent.

DEPOSITS, ORES, AND GANGUES.

For detailed descriptions of domestic quicksilver deposits the reader should consult the considerable literature, references to which

are given in preceding Survey reports on this subject. In the report on quicksilver for 1911 the writer gave a summary and generalization on deposits, ores, and gangues mainly for the benefit of those not needing great detail, or of miners, prospectors, or others to whom the literature is not readily accessible. Prospectors have apparently found the information useful. Copies of that report are still available for free distribution by the Survey. A more complete treatment of the subject will follow further field work and will be published in a future report of this series.

RESOURCES, OCCURRENCES, AND DEVELOPMENTS, BY STATES.

ARIZONA.

There was no production of quicksilver reported in Arizona in 1911. In the Plomosa district, in Yuma County, is the property of the Cinnabar Development Co., described by Bancroft.[1] The plant includes a 30-ton Scott furnace and a 3-ton Johnson & McKay retort. The retort was reported in operation during a short period in December.

CALIFORNIA.

The references to the literature on the geology, mining, and metallurgy of quicksilver are many and will be found in the bibliographies given in the Survey reports for 1910 and 1911.

The most useful general discussions of quicksilver in California are contained in the monograph by Becker [2] and the bulletin by Forstner,[3] and these references should both be consulted by anyone investigating the subject.

The quicksilver industry of California was normal in 1912. The larger producers continued steady output, but many of the smaller mines made less progress. There was considerable development and prospecting work and at several mines important tonnages of ore were reported available for treatment.

The production of quicksilver in California in 1912 was 20,524 flasks, valued at $863,034, an increase in quantity of 1,664 flasks over the output for 1911, but a decrease in value of $4,714. It was the largest output and, with the exception of that of 1911, the most valuable since 1905. In 1912 California furnished 81.9 per cent of the total domestic production against 88.7 per cent in 1911, 83.5 per cent in 1910, and 76 per cent in 1909.

The following table shows the quicksilver production of California, from earliest recorded output in 1850, to date, giving the best available data for quantity of flasks produced and average San Francisco domestic price per flask. The flask was of 76½ pounds of quicksilver each until June, 1904, since which date it has been of 75 pounds.

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[1] Bancroft, Howland, Notes on the occurrence of cinnabar in central western Arizona: Bull. U. S. Geol. Survey No. 430, 1910, pp. 151–153.

[2] Becker, G. F., The geology of the quicksilver deposits of the Pacific slope: Mon. U. S. Geol. Survey, vol. 13, 1888.

[3] Forstner, William, The quicksilver resources of California: Bull. California State Min. Bur. No. 27, 1903.

Quicksilver production of California, 1850–1912, in flasks.

Year.	Flasks.	Price per flask.	Value.	Year.	Flasks.	Price per flask.	Value.
1850	7,723	$99.45	$768,052	1883	46,725	$28.75	$1,343,344
1851	27,779	66.93	1,859,248	1884	31,913	30.50	973,347
1852	20,000	58.33	1,166,600	1885	32,073	30.75	986,245
1853	22,284	55.45	1,235,648	1886	29,981	35.50	1,064,325
1854	30,004	55.45	1,663,722	1887	33,760	42.375	1,430,580
1855	33,000	53.55	1,767,150	1888	33,250	42.50	1,370,625
1856	30,000	51.65	1,549,500	1889	26,464	45.00	1,190,880
1857	28,204	48.73	1,374,381	1890	22,926	52.50	1,203,615
1858	31,000	47.83	1,482,730	1891	22,904	45.25	1,036,406
1859	13,000	63.13	820,690	1892	27,993	40.71	1,139,595
1860	10,000	53.55	535,500	1893	30,164	36.75	1,108,527
1861	35,000	42.05	1,471,750	1894	30,416	30.70	933,771
1862	42,000	36.35	1,526,700	1895	36,067	37.04	1,335,922
1863	40,531	42.08	1,705,544	1896	30,765	34.96	1,075,544
1864	47,489	45.90	2,179,745	1897	26,691	37.28	995,040
1865	53,000	45.90	2,432,700	1898	31,092	38.23	1,188,647
1866	46,550	53.13	2,473,202	1899	29,454	47.70	1,404,956
1867	47,000	45.90	2,157,300	1900	26,317	44.94	1,182,686
1868	47,728	45.90	2,190,715	1901	26,720	48.46	1,294,851
1869	33,811	45.90	1,551,925	1902	28,972	43.20	1,251,590
1870	30,077	57.38	1,725,818	1903	30,526	45.29	1,382,523
1871	31,686	63.10	1,999,387	1904	29,217	43.50	1,270,940
1872	31,621	65.93	2,084,773	1905	24,635	36.22	892,280
1873	27,642	80.33	2,220,482	1906	20,310	39.50	802,245
1874	27,756	105.18	2,919,376	1907	17,431	39.60	690,268
1875	50,250	84.15	4,228,538	1908	16,984	44.17	750,183
1876	72,716	44.00	3,199,504	1909	16,078	45.45	730,745
1877	79,395	37.30	2,961,434	1910	17,211	46.51	800,484
1878	63,880	32.90	2,101,652	1911	18,860	46.01	867,749
1879	73,684	29.85	2,199,467	1912	20,524	42.05	863,034
1880	59,926	31.00	1,857,706				
1881	60,851	29.83	1,815,185	Total	2,124,732		95,275,695
1882	52,732	28.23	1,488,624				

The total value of the quicksilver production of California, from earliest output to date, may be taken at $95,275,695. The highest annual value of the production in this period of 63 years was $4,228,538 in 1875, when the output was 50,250 flasks of 76½ pounds each, and the average annual price was $84.15 a flask; and the lowest value was $535,500 in 1860, when the output was estimated at 10,000 flasks of 76½ pounds each and the average annual price was $53.55. The highest number of flasks produced in any one year was 79,395 in 1877, and the lowest was 7,723 in 1850. The highest price was $105.18 in 1874 and the lowest $28.23 in 1882. For the period considered the average annual value of the production has been $1,465,708; the average annual output, 33,726 flasks; and the average annual price, $44.84 a flask, whether of 76½ pounds or 75 pounds net each.

The output of quicksilver in 1912, as compared with that of 1911, was reduced in Lake and San Benito counties, but increased in Napa, San Luis Obispo, Santa Clara, and Sonoma counties. No production was reported from Colusa, Eldorado, Kings, Mendocino, Monterey, Siskiyou, Solano, Stanislaus, and Yolo counties in 1912. As usual the county leading in output was San Benito, which contains the New Idria mines, the most important producers of recent years in the Western Hemisphere. The next county in rank was Santa Clara, in which are the new Almaden mines, credited with the greatest total output in the country to date, and the Guadalupe, the second largest producer in 1912 after the New Idria. Third in rank was Sonoma County, which displaced Lake County in this respect.

There were 17 producing quicksilver mines in California in 1912. The total tonnage of ore mined was 138,198 short tons, against 131,336

tons in 1911 and 119,072 tons in 1910. The ore treated in California in 1912 was 139,347 short tons, against 130,926 tons in 1911 and 115,306 tons in 1910. Of the tonnage treated in 1912 the retorts received 1,056 short tons, producing 426 flasks of metal, and the furnaces treated the remainder, or 138,291 tons, producing 20,098 flasks. The average recovery of metal from ore in California in 1912 was 11 pounds per ton of ore treated, against 10.8 pounds in 1911, or 0.55 per cent of the ore in 1912, 0.54 per cent in 1911, and 0.52 per cent in 1910—a steady though small apparent gain in recovery. The average percentage of the crude ore treated recovered as metal was 1.04 from retorts and 0.54 from shaft furnaces.

The production of quicksilver in California in 1910, 1911, and 1912 is shown by counties in the following table:

Production of quicksilver in California, by counties, during 1910, 1911, and 1912, in flasks of 75 pounds.

County.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Colusa			(a)	(a)		
Fresno					(a)	(a)
Lake	1,148	$53,394	829	$38,143	209	$8,789
Napa	621	28,883	267	12,285	286	12,026
San Benito	10,804	502,494	9,809	451,312	9,754	410,156
San Luis Obispo	(a)	(a)	244	11,226	609	25,608
Santa Barbara			(a)	(a)	(a)	(a)
Santa Clara	4,038	187,807	7,533	346,593	8,695	365,625
Sonoma	67	3,116	94	4,325	641	26,954
Trinity	(a)	(a)	(a)	(a)	(a)	(a)
Other counties b	533	24,790	84	3,864	330	13,876
Total	17,211	800,484	18,860	867,748	20,524	863,034

a Included in "Other counties."
b San Luis Obispo and Trinity combined for 1910; Colusa, Santa Barbara, and Trinity for 1911; Fresno Santa Barbara, and Trinity for 1912.

Colusa County.—The Ruby King mine, in Colusa County, has proven of more value in its supplies of mineral paint than of quicksilver ore. Operations for the latter have therefore been abandoned. The paint deposits are reported to be sienna. A plant was in course of erection in 1912 for the development of the paint. The Manzanita mine, in the Sulphur Creek district, was idle in 1912.

Eldorado, Fresno, and Kings counties.—There was no output of quicksilver in Eldorado or Kings counties in 1912, but a considerable tonnage of ore was mined at the Mercy mine at South Dos Palos in the Little Panoche district in Fresno County, and was treated in the new 20-ton Scott fine-ore furnace and the two D retorts with a capacity of 1,000 pounds each 24 hours. The new plant began production in August and the mine was producing about 25 tons of ore each day with 25 men employed. The first furnace, a coarse-ore 20-ton plant, was taken down in 1912. At the Archer prospect, near Coalinga, in Fresno County (in the New Idria district), a small tonnage was mined in 1912. The plant includes five pipe retorts with a capacity of 150 pounds per charge. In Kings County, at the Summit claim some tunnel work was done. Erection of a 10-ton Scott furnace failed owing to unsatisfactory brick employed.

Lake County.—The production of quicksilver in Lake County in 1912 was 209 flasks, valued at $8,789, against 829 flasks, valued at $38,143, in 1911, and 1,148 flasks, valued at $53,394, in 1910.

At the old Mirabel mine all work has been suspended for several years past. At the Utopia prospect, which is reported to indicate considerable supplies of low-grade ore, no work has been done for 15 years. The Baker prospect was also idle. The King of All group, in Lower Lake district, was prospected, and a body of high-grade ore was reported ready for retorts in 1912. At the Chicago prospect only repair work to roads and tunnels was reported. The Bear Canyon prospect was idle in 1912.

The Wall Street and Helen mines were visited by the writer in 1912 and the following notes were obtained: The Wall Street mine, in Dry Creek canyon of the Mayacmas Range, is equipped with a small concentrating 3½-ton plant and D retorts (30 by 14 inches and 8 feet long) with a capacity of 600 pounds of ore a day. Both mine and plant were operated in 1912, and a small production was made. This is a remarkably efficient example of mine development and ore treatment on a small scale, as the entire work has been done to date by one man, W. H. Parsons, the owner, with the mechanical assistance of one horse. Below the roof of the "ledge" at the Wall Street mine and in blue serpentine (considerably silicified, but in part fairly soft) is a persistent narrow quartz vein parallel to the dip of the ledge. This vein serves as an indicator for ore from 2 to 3 feet above and below it in the serpentine country rock. The dip of both ledge and vein is about 30° S. 50° W. The vein is one-half inch to 1 inch wide, shows comb structure, and in its many cavities and geodes contains much native quicksilver—in fact, almost wherever the vein is broken in the workings the native metal drops out of the cavities. The serpentine from 1 to 3 feet both above and below the quartz vein carries about 4 per cent of both native metal and cinnabar, about in equal proportions, according to Parsons. The mineralized ledge itself is from 35 to 50 feet thick and outcrops conspicuously as brown iron-oxidized weathered material. The outcrop is prominent on the crest of the hill to the north of the plant and down the hillside and across the creek to the opposite side of Dry Creek canyon. A fault plane is indicated by broken ledge matter and reappearance of the ledge to the southeast. It also appears that a much greater northeast-southwest fault has broken the ledge at the Helen mine, farther up the canyon, and caused it to reappear, with characteristic southwest dip at the Wall Street. The characteristics of the ore bodies are much the same at both mines, the silicified ore-bearing serpentine ledges lying above softer blue serpentine and carrying quartz vein, cinnabar, and pyrite, and lenses of jasperoid. Old stopes of the Wall Street mine show ore still in place. The ore shoots appear to be 6 to 10 feet wide, including the quartz-vein indicator in the center. Cross fractures are lined with quartz, cinnabar, and native metal, and these ores are disseminated in the serpentine. Some of the soft ore is concentrated at the Wall Street mine before retorting, but the disseminated and jasperoid ore is treated crude.

At the Helen mine, on the east slope of the Mayacmas Range near the head of Dry Creek canyon, considerable development work and extraction of ore was accomplished in 1912, but the only metal recov-

ery was from furnace soot treated during the year. The plant includes a 50-ton Scott furnace, with condensers designed by the owner, Andrew Rocca, in which draft control is by dampers and is reported most satisfactory in operation. Mr. Rocca states that he can treat ore carrying only 0.25 per cent of metal at a profit. Soot and rich ore are treated in D retorts, with a capacity of 1,000 pounds of material per day. The mine workings of the Helen are all in serpentine. The mineralized ledge which has conspicuous northwest-southeast outcrop is in sheared and shattered serpentine with black gouge or "alta" hanging wall, and seams of white gouge in the ore body. The ore is chiefly cinnabar (intermixed in part with plentiful pyrite) and is in seams 1 to 2 inches thick, roughly parallel to the ledge and crossed by minute ore seams at high angles. The ledge itself is 100 to 200 feet thick, strikes about N. 82° W. (magnetic) and dips about 29° SW. The old workings of the mine are now marked by caved stopes and open cuts on the north exposures of the ledge. On the crest of the ridge to the north a basalt dike outcrops, and dikes of this have also been cut by the mine workings below. The present workings are known as the "new tunnel," which is driven to the west and lies just below the old workings of the former owners. In June, 1912, the tunnel had been driven about 404 feet, with short drifts in low-grade ore. The effort is being made to cut the early ore shoots at depth. The "old" or "upper" tunnel of the Helen mine lies southeast of the old and present workings, across the ravine, and was driven 316 feet to the southwest from below the hanging wall. Drifts from this tunnel produced large quantities of high-grade ore, and ore was stoped out to near the surface. About 300 feet vertically below the old tunnel and parallel with it lies the "long" tunnel, which was driven 1,200 feet S. 28° W. to cut the footwall of the ledge, from which point 1,000 feet of drifting in the ledge was done. The hanging wall was not reached, but a flow of water characteristic of the hanging wall was cut. Large quantities of pyrite in the serpentine and inflammable gas were encountered here and an explosion followed when the air pipe was broken and the foul air of the mine stood over night. Resumption of work is in prospect at the "old" and the "long" tunnels, which were idle in 1912. The prevailing country rock at the Helen mine, as stated, is serpentine. As exposed it is green to gray, much jointed, and cut by fine fibrous seams. It has apparently been greatly sheared and crushed. The mesh structure is conspicuous. The rock weathers in part in small spheroidal particles and in part crumbles to prismoidal and tabular fragments, finally disintegrating to loose, light-brown, not very fertile soil. In the old workings the rock is in part altered to soft bleached and iron-stained material, and in part carries lenses of hard, fine-grained jasperoid, and horses of unaltered rock. The black jasperoid, silicified, serpentine is itself cut by veinlets of quartz and cinnabar. Much of the silica is chalcedonic. The ore mineralization is mainly in the hanging wall and the footwall of the "ledge," favoring the footwall in the earliest workings on the north, and the hanging wall in the later workings to the south. There is much pyrite with the cinnabar and scattered through the serpentine, and although this mineral has a fuel value when fresh in the ore as sent to the furnace, it oxidizes rapidly in the wet workings of parts of the Helen mine and renders the work uncomfortable, and at times dangerous, for the miners. The

serpentine ore bodies are capped and cut by basalt, which weathers out in characteristic form and color on surface exposures.

At the old Great Western mine, where underground work has been suspended for several years and no operations but clean-up of the old furnace plant have been carried on, there was a small output of metal in 1912.

Mendocino and Monterey counties.—There were no quicksilver operations reported in Mendocino County in 1912, but in Monterey County the Parkfield (old Pitts) mine, near Parkfield, was prospected and the development of ore was reported.

Napa County.—The production of quicksilver in Napa County in 1912 was 286 flasks, valued at $12,026, against 267 flasks, valued at $12,285, in 1911, and 621 flasks, valued at $28,883, in 1910.

The Ætna mines, in Napa County, produced quicksilver from ore treated in retorts in 1912 and from clean-up of leakage from old furnaces. The retort plant is of the D type and is reported to be capable of treating 1,100 pounds to each of the two retorts in 24 hours. At the Knoxville mine ore was treated in the Livermore continuous furnace, and the two D retorts, with a capacity of half a ton each in 24 hours were also operated, but the work was mainly confined to prospecting and developing ore, as the owner reported trade conditions unsatisfactory for the sale of metal in 1912. At the Twin Peaks and other mines no more than assessment work was reported. The famous old Oathill mine or Napa Consolidated is reported worked out and has been entirely abandoned.

San Benito County.—The production of quicksilver in San Benito County was 9,754 flasks, valued at $410,156, in 1912, against 9,809 flasks, valued at $451,312, in 1911, and 10,804 flasks, valued at $502,494, in 1910.

At the Florence Mac prospect, in the Hernandez district of San Benito County, a small tonnage was extracted and treated in a single-pipe experimental plant in 1912. At the Tiger property prospecting only was done, and at the Ramirez or Hernandez, which is equipped with a 4-pipe retort plant, no work was reported, pending reorganization of the company.

At the New Idria district a considerable tonnage of ore was reported extracted and treated in pipe retorts at the Alpine mine. The retorts are 12 inches in diameter by 8 feet long, and the plant of 20 retorts treats 4 tons per 24 hours, but the recovery has been reported to be only 40 per cent, and therefore unsatisfactory. Operations extended through 172 working days. Much water and explosive gas were reported uncovered in the workings, and new arrangements for drainage and ventilation have been planned.

At the Esmeralda properties only a small output of metal was made, operations being confined mainly to further experimentation with a rotary furnace, according to reports from the company.

The New Idria mine continued to be the most important quicksilver producer in America. The mine was briefly described in the Survey report for 1908.[1] The property is equipped with one 60-ton fine-ore Scott furnace and two 80-ton coarse-ore furnaces designed by the general superintendent, B. M. Newcomb. The furnaces were

[1] McCaskey, H. D., Quicksilver: Mineral Resources for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 686–689.

operated during most of the year, treating 76,348 short tons of ore, according to the published company report, against 67,706 tons in 1911, and producing 9,600 flasks of quicksilver, against 9,750 in 1911. Oil was largely used as fuel in place of wood, with satisfactory results. Drifts and tunnels were extended 11,080 feet in 1912, against 3,167 in 1911. The great increase in underground work was required in extending the tunnel to the San Carlos ore body and in prospecting and developing the old mine. No new shaft sinking was done, but raises were made and winzes sunk to open available ore supplies. The work is the old mine extended from level No. 1 to No. 10. Good ore has been reported on the lowest level No. 10, and ore has been found in parts of the old workings formerly considered worked out. The tunnel, Molino No. 1, is more than half way to the San Carlos ore body and has cut two ore zones showing good veins and was passing through a third at the end of the year. Conditions of the quicksilver trade were reported unsatisfactory owing to competition among American producers which brought the domestic price below the parity of the London market.

San Luis Obispo County.—The production of quicksilver in San Luis Obispo County in 1912 was 609 flasks, valued at $25,608, against 244 flasks, valued at $11,226, in 1911.

At the Oceanic mine a considerable tonnage was extracted and treated in the 50-ton Scott fine-ore furnace (which was largely reconstructed) and furnace soot was treated in the retort plant of two D retorts. A large tonnage of low-grade ore was reported available for treatment, but trade conditions were reported discouraging. At the Doty mine a considerable tonnage of favorable grade was reported developed. The Sierra Morena or old Klau mine was reported idle in 1912. At the Josephine property assessment work only was done. At the Capitola prospect a small output was made from a D retort with a capacity of 1,000 pounds per 24 hours. At the Rinconada mine, equipped with two 12-pipe retorts, ore was developed but not treated owing to the need of repairs to the retorts. The Cypress Mountain and other properties were reported idle in 1912.

Santa Barbara County.—In Santa Barbara County there was a small output of ore at the Acachuma prospect, and quicksilver was produced from a bench of 12 pipe retorts. At a depth of 75 feet good ore was reported and preparations were made for increased output in 1912. Other quicksilver properties in the county were reported idle or doing assessment work only in 1912.

Santa Clara County.—The quicksilver production of Santa Clara County in 1912 was 8,695 flasks, valued at $365,625, against 7,533 flasks, valued at $346,593, in 1911 and 4,038 flasks, valued at $187,807, in 1910.

The Phoenix, Grayson, Miller, Dinero, and other prospects were idle in 1912, but the New Almaden and the Guadalupe mines made important production. At the Guadalupe mine a large tonnage was produced and treated during the year. The plant includes 2 fine-ore 14-ton furnaces and 2 coarse-ore 24-ton furnaces, all using oil as fuel. The Guadalupe mine has had a vigorous development and a notable output in recent years. The famous New Almaden mine, with the largest total production to date of all the domestic quicksilver mines, again made an important production from old and new ore. The old

underground workings of this mine are over 100 miles in extent, but they are almost entirely abandoned and production is reported from new ground and from discarded ore hoisted in earlier years. The equipment includes a Scott tile and shaft furnace plant with total capacity of 154 tons per 24 hours. This plant was the origin of the Scott modification of the Hüttner furnace, now so generally used.

Siskiyou and Solano counties.—In Solano County a considerable tonnage was reported extracted at the St. John mine in 1912, but none was treated. There were no operations in Siskiyou reported during the year.

Sonoma County.—The quicksilver production of Sonoma County in 1912 was 641 flasks, valued at $26,954, against 94 flasks, valued at $4,325, in 1911 and 67 flasks, valued at $3,116, in 1910.

In the Mayacmas district the Culver-Baer and the Cloverdale mines both produced again. The Culver-Baer mine produced a considerable tonnage which was treated. The plant includes a 16-ton coarse-ore furnace and a 24-ton Scott fine-ore furnace.

The Pacific, Great Eastern, and other quicksilver properties in Sonoma County were not operated in 1912.

Stanislaus County.—The Newhall prospect in the Deer Park district of Stanislaus County was under continued development in 1912, but the tunnels being driven had not yet cut the ore-bearing ledge outcropping on the ridge.

Trinity County.—In Trinity County the Altoona mine again made a small output, but the other quicksilver prospects were idle in 1912.

IDAHO.

There were no production of quicksilver or operations of quicksilver mines reported in Idaho in 1912. The occurrences of cinnabar in the State were described in the Survey report for 1911.

NEVADA.

Figures for the production of quicksilver in Nevada and Texas have been combined for 1911 and 1912 to conceal individual output. The production reported to the Survey by the operators of both States for 1912 was 28,396 short tons of ore mined, 16,346 short tons of ore treated, and 4,540 flasks of quicksilver, valued at $190,907, recovered. In 1911 the production of both Nevada and Texas was 12,246 tons of ore mined, 7,599 tons treated, 2,396 flasks of quicksilver, valued at $110,240, recovered.

The occurrences of quicksilver ore in Nevada and references to the literature, were noted in considerable detail in the Survey report for 1911.

Humboldt County.—The Ruby prospects in the old El Dorado mining district in the Humboldt Mountains were reported under development in 1912. In American Canyon, near Fitting, development was reported of prospects of gold and cinnabar in gravels by the Associated Placer Mining Co. The gravels are reached by shafts and it is proposed to crush and concentrate the material mined, separating gold in sluice boxes and cinnabar on Wilfley tables. At the Walker property, also, cinnabar ores were reported crushed in Huntingdon mills and concentrated on Card concentrators, the concentrates being

retorted. The Nevada Almaden prospects were under development in 1912.

Nye County.—The quicksilver deposits of the old Ione district, in the Shoshone Mountains of Nye County, were briefly described by the writer in the Survey report for 1911. At the Mercury mine a considerable quantity of ore was treated in the new 25-ton Scott furnace, the first in Nevada, yielding an important output of quicksilver. The Shoshone mines were under development in 1912, but made no production of metal. The plant includes 12 pipe retorts, and though these made considerable production from rich ores the first years of operation, they have been idle since, owing to salivation of the workmen and the desire of the mine owners to develop larger quantities of average ore for shaft-furnace reduction, rather than select rich ore for the retorts. The Shoshone properties have been recently acquired by the Nevada Cinnabar Co., of Salt Lake City, according to reports, and a 50-ton Scott furnace is in prospect of erection.

On Bare Mountain, near Beatty, a considerable number of quicksilver prospects have been under active development by shaft and crosscut for the last two years. At the Telluride Consolidated property a 10-ton Scott furnace has been erected in Gold Gulch, and on the Telluride group a small tonnage was treated the latter part of 1912 in a D retort, with a capacity of 800 pounds in 12 hours.

OREGON.

There were no quicksilver operations reported in Oregon in 1912. The occurrences of quicksilver ore and references to the literature were given in some detail in the Survey report for 1911.

TEXAS.

Figures for the output of quicksilver in Texas in 1912 and 1911 have been combined with those of Nevada to conceal individual production. The output of both States, as reported to the United States Geological Survey, was 28,396 short tons of ore mined, 16,346 tons treated, and 4,540 flasks of metal, valued at $190,907, in 1912, against 12,246 tons of ore mined, 7,599 tons treated, and 2,396 flasks of quicksilver produced, valued at $110,240, in 1911.

The following table shows the quicksilver output of Texas from the beginning of operations in 1899 to the end of 1910:

Production of quicksilver in Texas, 1899–1910, in flasks.[a]

1899	1,000	1906	4,761
1900	1,800	1907	3,686
1901	2,932	1908	2,382
1902	5,319	1909	4,188
1903	5,029	1910	3,320
1904	5,336		
1905	4,723	Total	44,476

Brewster County.—The quicksilver deposits of the Terlingua region of Brewster County, which have supplied the entire output of

[a] Flasks, 76½ pounds net; 75 pounds since June 1, 1904.

metal from the State, have been described in the Survey reports by the writer for 1907 and 1910, and lists of references to the literature have been given.

The only operations in the Terlingua region in 1911 and 1912 were those at the Chisos mine, where active development and production have continued.

UTAH.

There has been no output of quicksilver in Utah since 1907. The production, occurrences of ore, and references to the literature were summarized in the Survey report by the writer for 1911.

WASHINGTON AND ALASKA.

There has been prospecting only for quicksilver ores in Washington and in Alaska to date. At the Leavenworth mine, in Chelan County, Wash., considerable bodies of quicksilver ore have been reported, and the erection of a 25-ton Scott furnace was contemplated. The occurrences and references to the literature were given in the Survey report for 1911.

WORLD'S PRODUCTION.

The following table gives the world's estimated production of quicksilver, in metric tons of 2,204.6 pounds, for the years 1903–1911. For foreign countries the quantities given are partly from the corrected figures of the Eighteenth Annual Issue of Comparative Statistics, compiled by the Metallgesellschaft, Metallurgischen Gesellschaft A. G., and the Berg- und Metallbank Aktiengesellschaft, of Frankfort on the Main, Germany; for the United States the figures are those of the United States Geological Survey; and for Spain for 1907 and 1908 they are those of United States Consular Agent A. E. Carleton, published in the Daily Consular and Trade Report No. 3585.

World's production of quicksilver, 1903–1911, in metric tons.

Country.	1903	1904	1905	1906	1907	1908	1909	1910	1911
United States	1,237	1,188	1,036	892	734	672	717	701	723
Austria-Hungary	575	550	570	577	610	630	609	694	793
Italy	313	357	369	418	423	680	771	894	931
Russia	362	332	318	210	130	49	7	4	.....
Spain	968	1,130	853	1,567	1,210	1,065	1,393	1,114	1,486
Mexico and others	188	*a* 190	*a* 190	*a* 200	*a* 200	*a* 200	*a* 200	*a* 200	*a* 150
Total	3,643	3,747	3,336	3,864	3,307	3,296	3,697	3,607	4,083

a Partly estimated.

A considerable increase is noted for the world's output for 1911, and for the production of Spain and Austria-Hungary, the latter taking third rank in 1911 instead of the United States. The output of Russia has apparently declined to nothing. Trustworthy figures for the production for 1912 are not yet at hand.

IMPORTS AND EXPORTS.[1]

The American import and export trade in quicksilver was merely nominal in 1912. The imports were almost wholly into the port of New York, and the exports are indicated by countries to which exported in the tables following:

Quicksilver imported and entered for consumption in the United States, 1905–1912, in pounds.

Year.	Quantity.	Value.
1905	2,690	$1,710
1906	84	50
1907	16,567	6,719
1908	15,113	8,216
1909	15,968	8,203
1910	667	381
1911	471,944	251,386
1912	82,706	39,920

Exports of quicksilver from the United States, 1905–1911, in flasks of 75 pounds.

Year.	Quantity.	Value.
1905	13,534	$489,756
1906	6,456	243,914
1907	5,132	192,094
1908	2,996	124,960
1909	6,802	266,243
1910	1,923	91,077
1911	291	13,995
1912	310	13,360

Exports of domestic quicksilver from the United States in 1910, 1911, and 1912, by countries, in pounds.

Country.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Canada	81,745	$52,590	9,585	$6,318	6,413	$3,598
Costa Rica	2,475	1,585	2,550	1,594	4,150	2,447
Guatemala					900	505
Honduras	1,194	763	229	143	409	287
Nicaragua	1,979	1,212	1,436	905	355	251
Panama	285	175			95	64
Salvador	375	220	300	181	300	160
Mexico	48,678	29,736	5,285	3,262	3,130	1,816
Newfoundland			75	48		
Cuba					75	43
Dutch West Indies					25	18
Santo Domingo	20	17	95	63	280	170
Brazil	1,081	757	54	36		
Colombia	2,718	1,630	1,662	1,088	1,030	562
Ecuador			45	36		
Dutch Guiana	95	63				
Venezuela	26	18	75	45	4,546	2,539
Chosen (Korea)	1,950	1,314			1,575	900
Philippines	1,616	997	450	276		
Total	144,237	91,077	21,841	13,995	23,283	13,360

[1] For statistics of imports and exports acknowledgment is made to the Bureau of Foreign and Domestic Commerce, Department of Commerce, which has kindly supplied data requested especially for this report.

Exports of domestic quicksilver from San Francisco in 1910, 1911, and 1912, by countries, in flasks of 75 pounds.

Country.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Canada	34	$1,559	10	$440	1	$42
Costa Rica	32	1,530	30	1,390	48	2,054
Guatemala					12	505
Honduras	15	720	1	50	2	86
Nicaragua	5	250	8	357		
Salvador	5	220	4	181	4	160
Mexico	517	24,184	60	2,783	40	1,741
Colombia	1	51	5	263	12	480
Chosen (Korea)	26	1,314			20	850
Philippines	13	605	2	95		
Russia in Asia					1	50
Total	648	30,433	120	5,559	140	5,968

PRICES.

Prices of quicksilver in 1912 were materially below those of 1911 and of the years immediately preceding, as is shown in the following table:

Average yearly prices of quicksilver in the United States, and highest and lowest London quotations from 1907 to 1912, inclusive.[a]

Year.	San Francisco (flask of 75 pounds).		New York (flask of 75 pounds).	London (bottle of 34.5 kilos).	
	Domestic.	Export.		Highest.	Lowest.
				£ s. d.	£ s. d.
1907	$39.60	$38.17	$41.50	8 5 0	6 15 0
1908	44.17	42.54	44.84	8 10 0	7 12 6
1909	45.45	43.45	46.30	9 17 6	7 19 0
1910	46.51	44.51	47.06	9 15 0	8 0 0
1911	46.01	43.62	46.54	10 0 0	7 10 0
1912	42.05	39.55	42.46	£8 14s.[b]	

[a] From Eng. and Min. Jour., New York. [b] Average London price, 1912.

BIBLIOGRAPHY.

In the Survey report on quicksilver for 1910 a fairly complete list of the references to the literature on quicksilver for the North American continent was given, and this list was brought to the end of 1911 in the Survey report for that year. A new and complete list giving all references to the end of 1913 will be published in the report for the current year.

BAUXITE AND ALUMINUM.

By W. C. Phalen.

BAUXITE.

PRODUCTION.

The production of bauxite in the United States in 1912 was 159,865 long tons, valued at $768,932. Compared with the output in the preceding year these figures represent an increase in quantity of 4,247 long tons, or 2.7 per cent, and in value of $18,283, or more than 2.4 per cent. As in 1911, the increase in the output of bauxite was small. Though the growth of the industry in the future can hardly be expected to show the great gains which have occasionally marked its progress in the past, it is somewhat disappointing to record but a slight increment in the domestic production of the raw material of aluminum, a metal which is constantly enlarging its field of application. Moreover, the slight increase in the domestic production was not offset by increased imports, as the importation of bauxite decreased by 17,008 long tons, thus reducing the apparent net consumption of the mineral in this country for the year by 12,761 long tons. It is significant, however, that the importation of metallic aluminum of different grades increased enormously in 1912, which probably accounts for the small increase in the production, and the decrease in imports of the metal's ore, bauxite.

The States which produced bauxite in 1912 were as heretofore Alabama, Arkansas, Georgia, and Tennessee. Arkansas led in production as usual, but the output from this State was not so great as in 1911. The production in Alabama increased substantially and was greater than it has been for several years. A production is recorded from both the old and the new fields in Georgia, but the output from this State was less than in 1911. There was a gain in the output of Tennessee, and the new field near Elizabethton, Carter County, constitutes the second producing area in this State.

The average price of the ore per long ton at the mines for the last three years has been: 1910, $4.81; 1911, $4.82; 1912, $4.81.

The table following gives the production and value of bauxite from 1889 to 1912, inclusive.

Production of bauxite in the United States, 1889–1912, by States, in long tons.

Year.	Georgia.	Alabama.	Arkansas.	Total.	Value.
1889	728			728	$2,366
1890	1,844			1,844	6,012
1891	3,301	292		3,593	11,675
1892	5,110	5,408		10,518	34,183
1893	2,415	6,764		9,179	29,507
1894	2,050	9,016		11,066	35,818
1895	3,756	13,313		17,069	44,000
1896	7,313	11,051		18,364	47,338
1897	7,507	13,083		20,590	57,652
1898				25,149	75,437
1899	15,736	14,499	5,045	35,280	125,598
1900	19,739		3,445	23,184	89,676
1901	18,038		867	18,905	79,914
1902	22,677		4,645	27,322	120,366
1903	22,374		25,713	48,087	171,306
1904	21,913		25,748	47,661	235,704
1905	15,173		32,956	48,129	240,292
1906	25,065		50,267	75,332	368,311
1907				[a] 97,776	480,330
1908	14,464		[a] 37,703	52,167	263,968
1909	22,227		[a] 106,874	129,101	679,447
1910	33,096		[a] 115,836	148,932	716,258
1911	30,170		[a] 125,448	155,618	750,649
1912	19,587	14,173	[a] 126,105	159,865	768,932

[a] Production of Tennessee included.

CONSUMPTION.

The following table gives the annual production, imports, consumption, and value of bauxite in the United States during the last five years:

Production, imports, and consumption of bauxite in United States, 1908–1912, in long tons.

Year.	Production.		Imports.		Consumption.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1908	52,167	$263,968	21,679	$87,823	73,846	$351,791
1909	129,101	679,447	18,688	83,956	147,789	763,403
1910	148,932	716,258	15,669	65,743	164,601	782,001
1911	155,618	750,649	43,222	164,301	198,840	914,950
1912	159,865	768,932	26,214	95,431	186,079	864,363

WORLD'S PRODUCTION.

The following table shows the world's production of bauxite from 1909 to 1911, in so far as the figures are at present available:

World's production of bauxite, 1909–1911, in long tons.

Country.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	129,101	$679,447	148,932	$716,258	155,618	$750,649
France	128,099	251,188	192,913	379,052	(a)	(a)
United Kingdom	9,500	11,679	3,792	4,292	6,007	6,297
Italy	3,881	7,610	4,524	8,868	(a)	(a)
India	32	58	66	122	(a)	(a)
Total	270,613	949,982	350,227	1,108,592		

[a] Statistics not available.

NEW BAUXITE FIELD IN TENNESSEE.

In 1912 bauxite was mined for the first time on a commercial scale by the National Bauxite Co., in Carter County, Tenn., the exact location being about 1 mile northeast of Keenburg, a station on the Virginia & Southwestern Railway, and about 4 miles due north of Elizabethton, the county seat. The development thus discloses a new bauxite area in a locality nearly 200 miles northeast of the nearest known deposit, which is at Sherman Heights, near Chattanooga. Thus it appears that in the intermediate territory in the great Appalachian Valley promise of the discovery of pockets of the same material warrants thorough prospecting.

The geologic and structural conditions at the new deposit are, in their essential features, similar to those found in the deposits farther south, but the geologic mapping in the region about Elizabethton has been done in detail and more formations are delineated than in the areas covered by the older fields. The rocks in the Elizabethton area, described in the Roan Mountain folio of the United States Geological Survey, comprise Cambrian and Ordovician strata complexly faulted and folded.[1]

The ore body, like those in the Georgia-Alabama field, is in the form of a large irregular deep pocket inclosed in residual material resulting from the weathering of the Knox dolomite. The ore is chiefly of the massive pisolitic variety and has the following composition:

Analysis of bauxite from Carter County, Tenn.[2]

Alumina (Al_2O_3)	49.90
Iron oxide (Fe_2O_3)	4.13
Insoluble	18.38
Water	27.59
	100.00

SOURCES OF ALUMINA OTHER THAN BAUXITE.

Alumina from clay.—Though bauxite deposits are being found from time to time and though the present demand does not appear to tax unduly the known supply of the lower-grade material, the interest now being taken in the preparation of pure alumina from clay or other silicate minerals is worthy of note. As soon as a process for the extraction of alumina from clay is put on a commercial basis, large quantities of low-grade bauxite containing considerable admixtures of clay will become available. That there is a large tonnage of such material associated with most of the southern Appalachian bauxite is well known. This material should first be experimented with before the nonbauxitic clays containing the smallest amount of alumina are utilized.

Two processes have recently been patented for the extraction of alumina from clay, and other patents, having for their object the extraction of potash salts and alumina from silicates like the feldspars, were taken out in 1912. The two processes alluded to may

[1] Keith, A., Roan Mountain folio (No. 151) Geol. Atlas U. S., U. S. Geol. Survey, 1907.
[2] Watkins, J. H., geologist Southern Railway Co., Washington, D. C., Eng. and Min. Jour., vol. 95, No. 12, 1913, p. 604.

be named the Cowles and the Childs processes, respectively, from their inventors, Alfred H. Cowles and David H. Childs.

Cowles process.[1]—Clay, carbonaceous matter in the form of either charcoal or sawdust, and salt are made into perforated briquets, which, after being dried in a kiln, are passed in flat cars through a long furnace which raises their temperature to about 1,035° C. Steam is blown into the discharge end of the furnace, while through the other end the loaded cars are gradually moved forward by a hydraulic pusher. The speed is under control. The weight and composition of the material on the cars is known and the correct amount of exhaust steam is passed into the furnace from the opposite end. The gases are sucked from the charging end and forced through a condensing system. The reaction which occurs varies according to the composition of the mixture, but sodium silico-aluminate and hydrocloric acid are the valuable products formed. The latter is condensed and saved. Any iron present in the clay is condensed as iron chloride in the first condenser of a multiple-series system. The acid produced is very pure. When briquets containing 32 per cent sodium oxide are used the output of 30 per cent acid should be about 1½ tons per ton of salt and clay charged into the furnace.

The sodium silico-aluminate, which is acid in reaction, is next treated to obtain from it the sodium aluminate. The calcined briquets are ground and treated with enough lime to combine with the silica to form dicalcium silicate. The chemical equivalent of limestone, calcite or marl, may be used instead of anhydrous lime. The mixture of lime and acid salt is heated in a furnace just to the clinkering temperature. On being discharged it is broken up and leached. Nearly all the sodium aluminate may be leached from the clinker; the residue is a white mass of dicalcium silicate containing some sodium aluminate. The method of procuring alumina and caustic soda from the solution is the one in general use. The dicalcium silicate with one molecular weight more of lime is of use in white cement mixtures.

The process outlined opens the way to obtain alumina cheaply or as a by-product with other products which are consumed on a large scale in the industries. Cowles believes that with the introduction of the process the cost of production of metallic aluminum will be reduced 4 or 5 cents a pound.

Childs process.[2]—The Childs process consists of producing aluminum fluoride, which when calcined in the presence of water or water vapor produces alumina (Al_2O_3) as a solid and hydrofluoric acid (HF) as a gas. Hydrofluoric acid gas, or some other volatile compound of fluorine—for example, silicon fluoride—is passed through kaolin (clay) kept moist by a steady flow of water. The water dissolves the gas, forming a dilute solution of it, which attacks the kaolin, the aluminum in it passing over into aluminum fluoride, which is dissolved in the water. The acid gas removed from the water allows the latter to take up more gas; thus more aluminum fluoride is formed; and there eventually results a strong solution of this compound. When the solution is evaporated the fluoride of aluminum

[1] Original communications, 8th Internat. Cong. App. Chemistry, vol. 25, pp. 119–124. See also patents Nos. 1040892, 1040893, 1040894, 1040895, and 1040977, all dated Oct. 8, 1912.

[2] Action of some fluorine compounds on clay, water, etc.: Original communications, 8th Internat. Cong. App. Chemistry, vol. 2, pp. 67–74; vol. 25, pp. 215–218. Also patents Nos. 1036453 and 1036454, dated Aug. 20, 1912.

is left in the form of crystals. The crystals may then be calcined to produce alumina, and the process may be repeated with the hydrofluoric acid gas which passes off during calcination.

In the second patent (No. 1036454) a process is described in which an aluminum silicate is mixed with aluminum fluoride and heated so that the fluorine reacts upon the silica, producing a volatile compound of fluorine and silicon, and leaving alumina. The silicon fluoride may then be passed through a compound of aluminum kept moist by a steady flow of water, with which it will combine, forming hydrated silicon oxide, which will precipitate, leaving a dilute solution of hydrofluoric acid, or hydrofluosilicic acid, or both.

The reactions may be expressed thus:

$$SiF_4 + 4H_2O = H_4SiO_4 + 4HF.$$
$$2SiF_4 + 4H_2O = H_2SiF_6 + 2HF + H_4SiO_4.$$

The hydrofluoric acid and the hydrofluosilicic acid thus formed will attack the aluminum compound and will produce aluminum fluoride in the way already described above. If the aluminum compound is clay or kaolin ($Al_2O_3 . 2SiO_2$), the reactions may be expressed thus:

$$6HF + 2SiO_2.Al_2O_3 = 2AlF_3 + 2SiO_2 + 3H_2O.$$
$$H_2SiF_6 + Al_2O_3.2SiO_2 = 2AlF_3 + 3SiO_2 + H_2O.$$

In carrying out the process approximately 4 pounds of aluminum fluoride is required for each pound of silica, whether free or combined, contained in the material used. The details of carrying out the process are explained in the text of the patent.

Peacock process.—During the last few years great interest has attached to the methods having as their object the extraction of potash salts from the feldspars chiefly, or in general from the silicate rocks containing 10 per cent or more of potassa. Such minerals and rocks usually contain alumina in appreciable quantities, and many of the processes described mention alumina as one of the valuable products formed, usually in a pure state.

One of these processes has been patented by Samuel Peacock (United States patent 1035812, dated Aug. 13, 1912). In this process feldspar is coarsely ground and then heated with carbonate of lime. The calcined mixture is pulverized through a 100-mesh sieve and enough soda or potash is added to furnish one chemical equivalent for each chemical equivalent of alumina present. The mixture is then boiled, preferably under pressure, with sufficient water to make a thin paste. The alumina is rendered soluble as an alkali aluminate, the silica remaining insoluble as calcium silicate. The soluble and insoluble materials are separated by filtration, and the alumina is recovered by passing carbon dioxide through the solution. All of the alkali can not be separated from the aluminate by this method and its presence in the alumina unfits the latter for certain uses. To remove the alkali, the alumina is carefully sampled and its content in alkali and silica is determined. There is then added enough amorphous silica to make with that already present one equivalent for each equivalent of soda or potash in the crude alumina. The mixture is treated in a digester by superheated steam at a pressure of five atmospheres, so that all the insoluble alkaline aluminate is decomposed. The material is filtered while hot and the precipitate is

washed. Silica and alkali are removed as alkaline silicates and alumina is left practically pure.

Serpek process.—The Serpek process deals primarily with the fixation of nitrogen, but it involves also the production of alumina as a by-product. This by-product will probably prove of importance to the commercial success of the process. The raw material is bauxite, and thus the process involves a purification of this mineral. The pure alumina formed by the process can not be used over again, as it requires a higher temperature to combine with nitrogen than when bauxite is used. Briefly, the process consists of heating bauxite and coke in air at a temperature of 1,600° to 2,000° C. The reaction is $Al_2O_3+3C+2N=2AlN+3CO$.

By proper treatment of the nitride with a solution of caustic soda or with solutions of alkaline aluminates (United States patent 1040439, dated Oct. 8, 1912) alumina and ammonia are formed. It is understood that the exploitation of the Serpek patents is to be undertaken in Norway and that the annual output, beginning in 1914, is calculated to be 40,000 tons of ammonium sulphate to be used as fertilizer.

USES OF BAUXITE.

The chief uses of bauxite were outlined in this report for 1910, as follows: (1) As raw material in the production of metallic aluminum; (2) in the manufacture of aluminum salts; (3) in the manufacture of bauxite bricks; (4) in the manufacture of alundum (fused alumina) for use as an abrasive. The use of bauxite in the manufacture of calcium aluminate to give a quick set to plaster compositions should be added, as well as the extended use which alundum is finding in the refractory industries. The two latter uses are described briefly further on.

1. The use of bauxite in the production of metallic aluminum is by far the most important of those enumerated above. A large part of the entire output of Arkansas is used in the metallic aluminum industry, and the figures of production from this State have shown phenomenal growth during recent years. A large part of the French product is also used in the manufacture of metallic aluminum.

2. Only the purer bauxite is used in the manufacture of chemicals, such as alum, aluminum sulphate, and aluminum salts in general. Freedom from oxide of iron is essential in the material to be used in the chemical manufactures.

3. The use of bauxite in the manufacture of bauxite brick for furnace linings has long been considered. It has been found by experiment that when the impure forms containing considerable iron oxide are exposed to intense heat the bauxite is converted into a solid mass of emery of such extreme hardness that it can barely be cut by steel tools and that it resists chemical, thermal, and mechanical action to a marked degree. The purer the bauxite used the more refractory it is, and the addition of bauxite free from iron oxide to refractory clays increases their alumina content and at the same time their refractoriness.

The high cost of the raw material, as well as of the manufacture of the bricks, makes the ultimate cost of bauxite brick high compared with the cost of silica or fire-clay brick.

Recent applications of bauxite in brick are in the lining of rotary cement kilns, lead-refining furnaces, and basic open-hearth steel furnaces, where a brick high in alumina and low in silica is required. Recent tests seem to show that bauxite brick are suitable for basic open-hearth furnaces, provided they can be made with less than 12 per cent silica; and experiments show that bricks with this low proportion of silica are as good as magnesite brick.

In preparing bauxite for use in kiln or furnace linings, the crude ore is first washed to remove some of the free silica and clayey impurities. It is next calcined at a temperature of 2,500° F., during which process it gives off its water of constitution, amounting to about 30 per cent of the raw ore, and undergoes great shrinkage in the meantime. In the calcination of bauxite according to modern methods rotary kilns are employed in which oil, gas, or powdered coal are used as fuel. The kilns should preferably be installed at the mines in order to save the cost of transportation of the large content of water present in the crude ore. It has been observed that the bauxite shrinks very little below a temperature of 2,390° F. Between this temperature and 2,500° F. the greatest shrinkage takes place. Accordingly, the lowest temperature at which bauxite should be calcined is about 2,500° F.

The calcined mineral may be bonded with fire clay, sodium silicate, or lime. As little as 4 per cent of plastic fire clay may be used as a bond in handmade brick. When bonded with lime the brick become quite hard a few hours after making, so hard that they will not take the impression of the finger nail. This setting or hardening is probably due to a reaction between the lime and the free silica whereby calcium silicate is formed, and the reaction may be analogous to that involved in the setting of silica brick when bonded with lime. After a careful drying the brick are burned in down-draft kilns at a high temperature, as a result of which process they become hard and tough. A brick 9 by 2½ by 4½ inches weighs 7½ pounds and stands a crushing test of 10,000 pounds per square inch.

4. Bauxite is used on a large scale in the manufacture of the artificial abrasive, alundum, at Niagara Falls. This abrasive is made in the electric furnace by fusing calcined bauxite. It is high in crystalline aluminum oxide and virtually amounts to a form of artificial corundum. Its quality is under complete control, and hence it can be duplicated with ease in the various abrasive products, a factor of great importance in any successful abrasive industry. Alundum is particularly efficient in the grinding of steel.

5. Lastly should be mentioned the application of bauxite in the manufacture of calcium aluminate to give a quick set to plaster compositions. For a full description of the use of bauxite in calcium aluminate the reader is referred to Mineral Resources for 1911.[1]

[1] Phalen, W. C., Bauxite and aluminum: Mineral Resources U. S. for 1911, pt. 1; U. S. Geol. Survey, 1912, p. 931.

ALUMINUM.

PRODUCTION.

There was an increase in the domestic production of metallic aluminum during the year 1912, but the large increase in the domestic consumption given in the table below is chiefly due to the increase in imports. The exports of the metal should also be considered, but their amount, judged from their value, does not affect the general statements made above.

The magnitude of the aluminum industry is shown in the table following, which gives the production since the beginning of the industry in 1883 and the domestic consumption of the metal since 1904.

Production, in pounds, of aluminum in the United States, 1883–1912.

1883	83	1899	6,500,000
1884	150	1900	7,150,000
1885	283	1901	7,150,000
1886	3,000	1902	7,300,000
1887	18,000	1903	7,500,000
1888	19,000	1904	[1] 8,600,000
1889	47,468	1905	[1] 11,347,000
1890	61,281	1906	[1] 14,910,000
1891	150,000	1907	[1] 17,211,000
1892	259,885	1908	[1] 11,152,000
1893	333,629	1909	[1] 34,210,000
1894	550,000	1910	[1] 47,734,000
1895	920,000	1911	[1] 46,125,000
1896	1,300,000	1912	[1] 65,607,000
1897	4,000,000		
1898	5,200,000	Total	305,358,779

EXPORTS.

The value of exports of aluminum and of manufactures of aluminum of domestic production for the last five years has been as follows:

Exports of aluminum of domestic production, 1908–1912.

1908	$330,092	1911	$1,158,603
1909	567,375	1912	1,347,621
1910	949,215		

EXPANSION OF THE ALUMINUM INDUSTRY.

The Southern Aluminum Co., with a capital of several million dollars, has been organized by an amalgamation of aluminum producers in France, of certain French and Swiss interests, and of certain metal interests in the United States and has acquired a water-power site on Yadkin River, near Whitney, N. C. The company has been engaged in the development of the property and has plans to erect a plant with a large capacity for the manufacture of metallic aluminum. It is reported in the current literature that the construction of the plant will be under the direction of Paul Heroult.

The projected size of the company and the additional fact that the importation of foreign aluminum is being stimulated by a keen

[1] Consumption. The figures for 1911 and 1912 do not include the weights of imported leaf aluminum and of miscellaneous manufactures of aluminum, whose values were, respectively, $1,980 and $12,760 for 1911 and $1,122 and $257,521 for 1912.

demand promise for the consumers in the United States a sufficient supply of the metal.

The Aluminum Co. of America has secured certain riparian rights in North Carolina and Tennessee and is planning development of the water power for use in an aluminum plant to be constructed at such a point as will insure good freight rates and an adequate labor supply. It is reported that the new aluminum plant will be in operation some time during 1913. In addition to its expansion in the South, the Aluminum Co. of America is reported to be working on an addition to its plant at Massena, N. Y., which, when completed, will be one of the largest in the world. It is reported that a large supply of electricity will be conducted from the development on the St. Lawrence at Cedar Rapids to Massena. Enlargements to the company's plant at New Kensington, Pa., and East St. Louis, Ill., are also reported.

THE ALUMINUM MARKET.

Little business was reported in the aluminum market at the beginning of 1912. Prices were the same as at the close of 1911, and ranged in early January from 18½ to 19 [1] cents a pound for No. 1 ingot metal in New York, these quotations being for transactions in the open market. Business continued fair, and the market both in the United States and abroad grew stronger toward the end of the month, with a slight rise from 19 to 19½ cents a pound. These prices held until the middle of February, when the market grew slightly stronger and metal rose from 19¼ to 19¾ cents, which prices obtained till early in March, when they reverted to 19 to 19½ cents. Toward the end of March, however, business began to improve, prices grew firmer, both on account of a firmer foreign market and of larger sales in the United States, and quotations increased to 19½ to 20 cents. During early April there was a further slight advance to 20 to 20½ cents, which figures held throughout the month. Early in May an announcement in Europe that the old aluminum syndicate would be renewed caused an advance abroad and prices here were advanced to meet the prices at which the foreign metal could be laid down in New York; these figures were 21 to 22 cents a pound. The market became somewhat firmer as May advanced, and toward the middle of the month quotations ranged from 21½ to 22½ cents. Trade became rather dull after this advance, but after low-priced lots of metal were sold out, prices went up in early June to about those established by the convention of the European producers and quotations rose to 22½ to 23 cents a pound. These prices continued throughout June, and as the last half of the year approached the activity that characterized the steel, copper, and other metal industries manifested itself in the aluminum industry and the demand generally exceeded the supply not only in the United States but also in Europe. In early July quotations ranged from 22½ to 23 cents, but toward the end of the month New York prices advanced to 24 to 24½ cents. These prices obtained well into August and as the month advanced and the metal became scarcer, there was a slight increase in early September to 24½ to 25 cents a pound. With good business and the market firm there was a slight increase as September advanced to 25¼ to 25½ cents. In early October prices went up sharply and sales

[1] Quotations for this and the preceding years have been taken from the Engineering and Mining Journal.

were reported made with the metal at 27 cents. Quotations for No. 1 ingot metal in New York were, however, 26 to 26½ cents, with fluctuations to 25 cents. At the end of October ingots were quoted at 26½ cents in large lots. Throughout the first half of November the aluminum market was strong and active. Business, instead of being dulled by the higher prices, seemed to have been stimulated, and current quotations were 27 cents for No. 1 ingots. Toward the end of the month prices became slightly easier, dropping to 26 to 26½ cents, and early in December slightly easier still, namely, at 25½ to 26 cents, with the market quiet, and these quotations remained unchanged throughout the rest of the year.

In the accompanying figure the fluctuation in the prices of metallic aluminum in the form of No. 1 ingots f. o. b. New York City is illustrated graphically for the years 1910–1912.

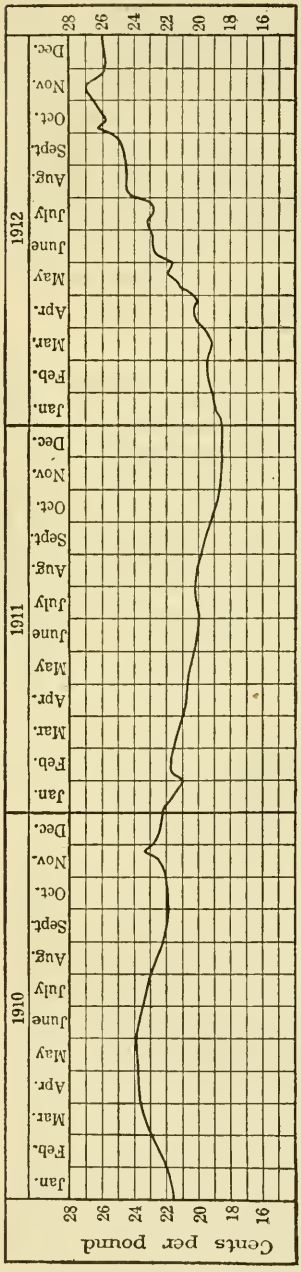

FIGURE 9.—Curve showing price by months, 1910–1912, of metallic aluminum in the form of No. 1 ingots f. o. b. New York City.

RECENT APPLICATIONS OF METALLIC ALUMINUM.

A recently developed branch of the aluminum industry is the manufacture of the powdered metal, known to the trade as aluminum-bronze powder, and used extensively as a paint pigment, in explosives, in lithographing, and in printing. To make the powder, foil made of the metal with a thickness of only 0.01 millimeter (0.0004 inch) is cut into squares of 2 millimeters, or 0.079 inch, on a side and rubbed to powder. The material feels like powdered graphite and is just as difficult to remove from the skin.

Aluminum foil, though not exactly a new product, is now being used on a larger scale than ever before, owing to improved methods in the making, after long and expensive experiments, which have lowered its cost appreciably. The rolling is reported to be effected in six stages, the last of which yields a foil 0.04 millimeter (0.0016 inch) in thickness. In order to get a thinner foil several sheets are laid together and either rolled or beaten like gold leaf. Aluminum foil has partly displaced tin foil for wrapping articles such as cheese, chocolate, candies, tobacco, etc. Aluminum foil is also reported to be used in the manufacture of electrical condensers.

The employment of metallic aluminum in the manufacture of cooking utensils and other articles of domestic use has been referred to in Mineral Resources in previous years. The use of the metal is now being extended on a much larger scale in the construction of tanks, cooking vats, and vessels which are employed by brewers, preserve manufacturers, and in similar industries where heat conduction, noncorrosion, and a nonpoisonous nature are essential. It is reported that an addition has been built to the cooking-utensil factory of the Aluminum Co. of America, located at New Kensington, Pa.

The expansion in the use of extruded forms and tubing has been great during the last few years. The difficulties encountered in making extruded shapes have been largely surmounted, and they are now being turned out with high tensile strength and with very compact structure in almost any form called for. The use of aluminum tubing outlined in the report for 1910 has also been expanding, and an extension to the tubing plant of the Aluminum Co. of America at New Kensington, Pa., is reported.

The use of aluminum wire as the conductor in long-distance power-transmission schemes is not new, but recent departures from the ordinary practice bid fair to enlarge this application of aluminum. It is reported that there has been placed upon the market a steel-reenforced aluminum cable consisting in all of seven strands. The six outer strands are made of aluminum, and the inner strand is made of steel of very high tensile strength. It is claimed for this conductor that it both transmits the current and has the requisite strength for use in the towers which are rapidly displacing poles in transmission lines. The Pacific Light & Power Co., of Los Angeles, has adopted this product for its new transmission line which is to carry power to Los Angeles over a distance of 275 miles.

According to the Mining Journal,[1] London, experiments made to bring aluminum to a liquid condition so that it may be spread when cold over any dry surface have, according to the German press, been crowned with success. The composition is applied like paint with a brush and looks, when spread, like a dull silver coating. It is said to be an excellent preventive of rust, to be resistant to heat, elastic, durable, and resistant to atmospheric influences, and to form an excellent substitute for tin in plating.

The employment of metallic aluminum in the manufacture of articles of everyday use has become so common that such articles fail to attract attention as novelties. The demand at the present time in this direction seems to be for skillful originality in designing new forms and applications.

ALLOYS.[2]

The tenth report to the Alloys Research Committee was presented at the April (1912) meeting of the Institute of Mechanical Engineers, London. This report contains, along with other information, results of a series of mechanical tests on alloys of aluminum and zinc and on ternary alloys made of aluminum, zinc, and copper. The authors of the report state that it is possible to cast sound and solid castings

[1] Min. Jour., London, June 22, 1912, p. 639.
[2] See also paper by H. W. Gillett, The influence of pouring temperature on aluminum alloys: Original communications, Eighth Internat. Cong. App. Chemistry, vol. 2, 1912, pp. 105–112.

of these alloys, even if of complicated design, without shrinkage and consequent cracking. Taking into account tests of dynamic and tensile strength, the report shows that the alloy containing 20 per cent of zinc is the most generally useful of the simple binary alloys. The detailed results of the tests are given in the Metal Industry for July and August, 1912.

Robert Grimshaw [1] describes an aluminum alloy which is said to be acid proof. There are many conditions or circumstances in which an alloy of this character is desirable; for example, in the manufacture of tubing, cocks and valves, cables, pumps, etc. The composition is 92 parts by weight of metallic aluminum, 2 of bismuth, 5 of copper, and 1 of silicon. In making the alloy the three elements mentioned last are melted together in a crucible and the aluminum is melted in another. When the contents of both crucibles become fluid they are mixed together.

According to the Mining Journal,[2] London, a process has been patented by W. Borchers whereby ordinary aluminum may be greatly improved by being alloyed with cerium in quantities up to 0.2 per cent. Resistance to snapping of the metal is doubled and its ductility is increased six to seven fold. The texture of the resulting alloy is finer and denser than that of the original aluminum, and objects made of it ring clear and pure like a bell. It has been found most suitable for foundry purposes, as it enters and fills the finest designs of the casting mold. Its strength and ductility give it an advantage over the ordinary metal in mechanical treatment.

SOLDERING ALUMINUM

A patent (No. 1029522) was granted June 11, 1912, to H. D. Avis, jr., of Clarksburg, W. Va., for coating aluminum or its alloys for soldering. Chlorides of tin and zinc are mixed in the ratio of 2 to 3 parts of the former to 1 of the latter. The mixture is heated and excess of hydrochloric acid is expelled. On cooling, the mass becomes of a pasty consistency after which a small amount of powdered tin is added. To tin the surface of the aluminum this paste is applied and the parts are heated below redness. When the proper temperature is reached, the aluminum is coated with the oxide of tin and zinc, which on removal with a brush or other means leaves a bright film of tin. The soldering then becomes as simple as that of tin.

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[1] Metal Industry, No. 8, August, 1912, p. 319. See also Jacquier, G., The Foundry, vol. 40, No. 10, October, 1912, p. 40.

[2] Min. Jour., London, July 6, 1912, 2, p. 694.

ALUMINUM SALTS.

PRODUCTION.

The following table gives the domestic production, the imports, and the value of aluminum salts from 1908 to 1912, inclusive:

Production and imports of aluminum salts into the United States, 1908–1912, in short tons.

Years.	Production.						Imports.[a]	
	Alum.			Aluminum sulphate.			Quantity.	Value.
	Quantity.	Value.	Per ton.	Quantity.	Value.	Per ton.		
1908	7,700	$236,710	$30.74	97,255	$1,835,213	$18.87	1,407	$24,929
1909	9,237	295,682	32.01	115,366	2,214,122	19.19	1,459	29,061
1910	9,090	300,763	33.09	126,792	2,447,552	19.30	2,127	53,671
1911	10,468	329,686	31.49	134,077	2,743,336	20.46	2,283	56,833
1912	9,246	293,995	31.80	150,427	2,909,495	19.34	3,342	84,606

[a] Includes alumina, aluminum hydrate, or refined bauxite, alum, alum cake, aluminum sulphate, aluminous cake, and alum in crystals or ground.

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ERRATA.

Page 973, line 37, read "Cobalt" for "cobalt."

Page 1004, line 5 from bottom, read "Uinta County" for "Uinta and Wasatch counties." Figure 2 should be turned so that the left side becomes the top.

Page 1006, line 30, read "southeast" for "south." Line 31, read "1 to 2 inches" for "5 to 6 inches." Line 13 from bottom, strike out "(Wild Horse Canyon.)"

Page 1007, insert before last paragraph the following: "The American Rare Metals Co. operated a mill on Dolores River 5 miles above McIntyre from July 1 to the end of the year. Carnotite ores were treated by the Fleck & Haldane patented method, and some radium concentrates were shipped."

Page 1008, line 2 from bottom, read "Cu" for "Ca."

Page 1010, line 4 from bottom of table, read "Monazite" for "Monaxite." Line 14 from bottom of page, read "3.4×10^{-7}" for "$3\ 4\times10^{-7}$."

Page 1012, insert between fifth and sixth paragraphs the following: "Experiments along similar principles but with very inadequate abrading methods were conducted by Fleck & Haldane in 1905, and owing to incomplete sliming they concluded that such a process was impracticable.[3]

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[3] Fleck, Herman, and Haldane, W. G., A study of the uranium and vanadium belts of southern Colorado: Rept. State Bureau of Mines, Colorado, 1905–6, Denver, 1908, pp. 100–102."

Page 1016, sixth paragraph, Analysis of samarskite from Mitchell County, N. C., by O. D. Allen, Am. Jour. Sci., 3d ser., vol. 14, 1877, pp. 130–131; Ta_2O_5, 18.60; Cb_2O_5, 37.20; SnO_2, 0.08; UO_3, 12.46; cerium oxides, 4.24; Y_2O_3, 14.45; FeO, 10.90; MnO, 0.75; CaO, 0.55; H_2O, 1.12; total, 100.35.

Page 1018, first column, line 10 from bottom, read "MgO" for "MqO."

Page 1019, note 6, read "Uranerze" for "Uranerge"; note 9, read "Russian" for "Prussian"; last line, read "Co_3O_4" for "CO_3O_4."

Page 1020, note 3, read "vol. 33" for "vol. 37."

Page 1021, the fifth paragraph is not part of the quotation.

Page 1024, note 5 should be read as a part of note 4.

Page 1026, concerning the float specimen mentioned in line 2, under "South Australia" add the following footnote:

[8] Loby, T. H., On a pitchblende probably occurring in New South Wales: Jour. and Proc. Roy. Soc. New South Wales, 1909, pp. 28–33.

Page 1026, last footnote read "9" for "8" (number of footnote).

Page 1028, note 7, fifth word, read "af" for "of."

Page 1029, note 1, line 2, before "Die Mineralien," etc., insert "also."

Page 1030, line 4, after "copper," strike out the comma.

Page 1031, line 7 from bottom, read "tjuyamunite" for "tjuamunite."

Page 1032, line 1, under "Madagascar," insert ")" after "UO_2."

Page 1034, line 1 of quotation under "Vanadium," read "black dye" for "brick dye."

Page 1037, add the following list:

TIN.

BLAKE, W. P., Tin: Mineral Resources U. S. for 1883–84, U. S. Geol. Survey, 1885, pp. 592–640. 40 cents.

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COLLIER, A. J., Tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 225, 1904, pp. 154–167. 35 cents.

——— The tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 229, 1904, 61 pp. 15 cents.

——— Recent development of Alaska tin deposits: Bull. U. S. Geol. Survey No. 259, 1905, pp. 120–127. 15 cents.

——— Tin ore at Spokane, Wash.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 295–305. 30 cents.

GRATON, L. C., The Carolina tin belt: Bull. U. S. Geol. Survey No. 260, 1905, pp. 188–195. Out of print.

——— Reconnaissance of some gold and tin deposits of the southern Appalachians, with notes on the Dahlonega mines by Waldemar Lindren: Bull. U. S. Geol. Survey No. 293, 1906, 134 pp.

HESS, F. L., The York tin region: Bull. U. S. Geol. Survey No. 284, 1906, pp. 145–157.

——— Tin, tungsten, and tantalum deposits of South Dakota: Bull. U. S. Geol. Survey No. 380, 1908, pp. 131–163. 40 cents.

——— The production of tin: Mineral Resources U. S. for 1911, pt. 1, U. S. Geol. Survey, 1912, pp. 963–972. Gives an epitome of the occurrences of tin in the United States.

HESS, F. L., and GRATON, L. C., The occurrence and distribution of tin: Bull. U. S. Geol. Survey No. 260, pp. 161–187. Out of print.

JOHNSON, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district [Alaska]: Bull. U. S. Geol. Survey No. 442, 1909, pp. 246–250.

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——— Geology of the Seward Peninsula tin deposits, Alaska: Bull. U. S. Geol. Survey No. 358, 1908, 72 pp.

RICHARDSON, G. B., Tin in the Franklin Mountains, Texas: Bull. U. S. Geol. Survey No. 285, 1906, pp. 146–149. Out of print.

——— El Paso folio (No. 166), Geol. Atlas U. S., U. S. Geol. Survey, 1909, 11 pp. 5 cents.

ROLKER, C. M., The production of tin in various parts of the world: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1895, pp. 458–538. $1.20.

ULKE, T., Occurrence of tin ore in North Carolina and Virginia: Mineral Resources U. S. for 1893, U. S. Geol. Survey, 1894, pp. 178–183. 50 cents.

VAN DER WYCK, O. H., The occurrence of tin ore in the islands of Banca and Billiton: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1896, pp. 227–242. $1.

WEED, W. H., The El Paso tin deposits: Bull. U. S. Geol. Survey No. 178, 1901, 15 pp. 5 cents.

——— Tin deposits at El Paso, Texas: Bull. U. S. Geol. Survey No. 213, 1903, pp. 99–102. 25 cents.

COBALT.

By Frank L. Hess.

During 1912 more advance was made in the use of cobalt than ever before, but no cobalt ores were produced in the United States during the year.

OCCURRENCE OF COBALT.

MISSOURI.

At Fredericktown and at Mine La Motte, Mo., cobalt is found in the mineral linnæite occurring with nickel (probably both in the linnæite and in pyrrhotite) and copper (in chalcopyrite) in the disseminated lead deposits. The other minerals are separated from the galena, and efforts have been made to utilize the cobalt, nickel, and copper. At one time a smelter was erected by the North American Lead Co. near Fredericktown, but it ran only a very short time.

IDAHO.

Near Blackbird, Lemhi County, Idaho, are cobalt-nickel deposits of potential commercial value which have been recently described by J. B. Umpleby [1] as follows:

Distribution.—The known cobalt-nickel deposits of the area are confined to the Blackbird district in the west-central part of the county. The most promising properties are situated near the junction of north and south forks of Blackbird Creek. Thence northward, prospects are located for 5 to 6 miles—the most northern ones being situated about the head of Little Deer Creek, a small stream which flows north into Big Creek.

Geologic relations.—The deposits are situated in an area of Algonkian schists and quartzites, cut by diabase and lamprophyre (minette) dikes. That a portion of the great granite batholith underlies part of the area is suggested by its occurrence in Big Creek valley and by the extensive metamorphism of the Algonkian sedimentary rocks. Biotite is the most abundant mineral developed, although locally garnet and chiastolite crystals were noted. In general the Algonkian beds strike N. 60°–80° E. and dip 40°–60° NW. Crossing their strike is a strong joint system which strikes N. 10°–40° W. and dips 80° SW.

Gabbro dikes as much as 100 feet wide parallel the mineralized belt in north-south direction. They are blue-black holocrystalline rocks consisting of hornblende, diopside, plagioclase, and biotite, with accessory pyrrhotite, pyrite, titanite, and apatite. Minette dikes appear to follow both the strike of the formations and the cross joints. They are fine-grained dark-gray resinous rocks consisting of biotite and orthoclase accompanied by subordinate amounts of plagioclase and hornblende.

Character of the deposits.—Most of the deposits are lenslike bodies, although a few assume the broadly tabular form of veins. Again, they form bunches or occur as disseminations along certain favored zones. In one place (Hawkeye group) irregular bunches of nickeliferous pyrrhotite up to 4 or 5 inches in diameter are sparsely scat-

[1] Geology and ore deposits of Lemhi County, Idaho: Bull. U. S. Geol. Survey No. 528, 1913, pp. 71–72.

tered through a gabbro dike. This pyrrhotite may be a direct segregation from the gabbro magma, but the fractured condition of the specimens secured precludes definite determination. Elsewhere deposits are primarily of replacement origin, the fine-grained metallic minerals being distributed in bunches, lenses, and disseminations along ill-defined zones in the schist or quartzite. The ore minerals are everywhere accompanied by quartz, which in places is coarse and includes them as gangue but elsewhere is exceedingly fine grained and is intergrown with them.

Ores.—Most of the outcrops of the cobalt-nickel deposits are stained by erythrite, the pink to pearl-gray cobalt blossom, and annabergite, the pale apple-green nickel compound. In addition, malachite, limonite, and pyrolusite are present in many outcrops. The primary cobalt and nickel minerals are difficult to recognize, owing to their occurrence in grains of microscopic size which are invariably intergrown with something else. At least two cobalt minerals in the area are probably primary. The one is a reddish-gray mineral (Gray Eagle claim) which occurs in very small grains replacing biotite and quartz in a garnetiferous biotitic quartzite; the other is a steel-gray mineral, which occurs as minute grains distributed through the quartzitic rock on the west end of the Beliel group. The former is probably cobaltite and the latter is possibly smaltite. Most of the nickel of the area is thought to be in the form of nickeliferous pyrrhotite, a specimen of this mineral from the Togo claim yielding 0.8 per cent nickel. A pale copper-red mineral, rarely seen in the Togo ores, may be niccolite.

The properties are too little developed to establish the tenor of the ores. A sample representing 20 feet across the ledge, as exposed by tunnel on the west end of the Beliel group, averaged a fraction less than 2 per cent cobalt. The east end of this property afforded 2 per cent of nickel and less than 1 per cent of cobalt. As now developed this seems to be the best cobalt-nickel deposit.

Age and genesis.—Within Lemhi County it is impossible to differentiate the times of deposition of the cobalt-nickel, copper, and gold deposits. The relations indicate that they all belong to the same general period of mineralization, and as the gold veins are assigned to the late Cretaceous or early Eocene and are genetically related to the great granite mass, the other deposits also are credited to the same age and origin. The coextent of the gabbro dikes and the cobalt-nickel deposits, and the inclusion of nickeliferous pyrrhotite in the gabbro in a manner to suggest its derivation from the gabbro magma, points to a close relation between the two. This, however, is probably a minor though an important feature in the broader relation between the granite batholith and the deposits.

The cobalt-nickel deposits, therefore, are thought to be of late Cretaceous or early Eocene age and to be genetically related to the great granite intrusion. They are closely associated with gabbro dikes, which are probably differentiations from the granite magma.

OREGON.

Cobalt in the form of smaltite is found with pyrrhotite, chalcopyrite, gold, and possibly other minerals in the claims of the Comer Mining Co. near Prairie City, Grant County, Oreg., but no production is known to have been made. Only assessment work was done during 1912.

CANADA.

The cobalt used in the United States comes mostly from Cobalt, Ontario, where it occurs as arsenides and sulphides in the silver veins. Cobalt oxide is made from these ores by the Orford Copper Co. at Constable Hook, N. Y. The Cobalt ores are also shipped to England and Germany and part of the refined product, either as cobalt metal, ferrocobalt, or cobalt oxide and other compounds, is shipped to this country.

The cobalt minerals have not generally brought much revenue to the mine owners of the Cobalt district, owing to the small demand for the metal. It seems probable now, however, that the demand will so increase that the mine dumps in which there is said to be a considerable quantity of cobalt minerals, will sooner or later be worked over for that metal.

Cobalt occurs in the deposits at Cobalt as smaltite (cobalt arsenide), cobaltite (cobalt sulph-arsenide), and as erythrite or cobalt bloom (hydrous cobalt arsenate).[1] Chloanthite, the nickel diarsenide ($NiAs_2$), and niccolite, the nickel arsenide (NiAs), also carry more or less cobalt which replaces the nickel.

SAXONY AND BOHEMIA.

It is possible that some cobalt from the mines of Saxony and Bohemia also finds its way to this country.

NEW CALEDONIA.

The cobalt deposits on the island of New Caledonia, in the south Pacific, are now unproductive, as they can not compete with the rich ores from the silver mines of Cobalt, Canada.

STELLITE.

Stellite, the alloy of cobalt and chromium invented by Elwood Haynes, of Kokomo, Ind., has been further improved by Mr. Haynes, and in its original combination of about 75 per cent cobalt and 25 per cent chromium is now being manufactured into table cutlery. A small carving knife which has been used by the present writer for more than two and one-half years for table use, cutting lemons, oranges, etc., without repolishing, retains practically its original luster, and the edge is equal to that of the best steel knives.

Mr. Haynes has found that by the addition of molybdenum and tungsten the cobalt-chromium alloy is made remarkably hard and that it makes good edged tools. He describes the alloys as follows:[2]

* * * * * * *

As early as 1907 and 1908, I made alloys or combinations of cobalt, chromium, and tungsten; cobalt, chromium, and molybdenum; and cobalt, chromium, tungsten, and molybdenum, I have made alloys of cobalt and chromium containing zirconium, tantalum, thorium, titanium, vanadium, etc. I have also added to the cobalt-chromium alloys the nonmetallic elements, carbon, silicon, and boron. Some exceedingly interesting results have been obtained from these various combinations, and while further investigation is necessary in order fully to determine their chemical and physical properties, a number of them have shown interesting economic possibilities.

* * * * * * *

The following experiment shows the effect of melting the alloy in a graphite crucible: 90 grams of cobalt, 6.3 grams of tungsten, 18 grams of chromium, together with a small quantity of calcium silicide, were introduced into a graphite crucible. The resulting alloy was very hard, and the crucible much eroded on the inside. The bar could be slightly flattened at one end, and after being made into a cold chisel, showed remarkable qualities. It would not only scratch glass, but also quartz crystal. It was quite tough at ordinary temperatures, and would cut small chips or shavings from a piece of stellite. At a bright yellow heat it showed signs of fusion, and became covered with a skin of oxide.

An alloy was made by melting the following in a special crucible: Cobalt rondelles, 80 grams; chromium, 20 grams; tungsten, 7 grams; calcium silicide, 10 grams; calcium carbide, 5 grams. As soon as these materials were melted, the crucible cover was removed, and 15 grams of an alloy of cobalt and boron was introduced. The crucible lid was then replaced and the heating continued. A heavy thick slag formed, which was removed before pouring the metal. The resulting bar was very hard and elastic, but only drew slightly under the hammer, and then broke. A cold chisel made from

[1] Miller, W. G., The cobalt-nickel arsenides and silver deposits of Temiskaming: Rept. Bur. Mines Ontario, pt. 2, 1905, pp. 8 and 14.

[2] Haynes, Elwood, Alloys of cobalt with chromium and other metals: Bull. Am. Inst. Min. Eng., February, 1913, pp. 249–253.

the cast metal cut iron readily. The bar was broken up and remelted with about one-third of its weight of an alloy of cobalt, chromium, tungsten, and carbon. The result was a fine-grain alloy which was very elastic, and would draw out to a considerable degree under the hammer without checking. Its elastic limit must have been very high, since, when it broke, the pieces were thrown violently.

Taking the alloy of chromium and cobalt as a basis, and holding the proportion of chromium at 15 per cent of the entire mixture, it was found that the alloy gradually increased in hardness with the percentage of tungsten. When the quantity of tungsten rises to 5 per cent, the alloy becomes distinctly harder, particularly when forged under the hammer. When the tungsten reaches 10 per cent, the metal still forges readily, and a tool formed from the alloy takes a fine cutting edge. This alloy is suitable for both cold chisels and woodworking tools. When the tungsten rises to 15 per cent, the metal can still be forged, but great care is necessary in order to avoid checking. This alloy is considerably harder than that containing 10 per cent of tungsten, and is excellent for cold chisels. When the tungsten rises to 20 per cent the alloy is still harder, and can be forged to a small extent. It makes good lathe tools for cutting steel and other metals at moderate speeds. When the tungsten rises to 25 per cent a very hard alloy results, which can not be forged to any extent, but casts readily into bars which may be ground to a suitable form for lathe tools. These tools have shown great capabilities, particularly for the turning of steel, since they are very strong, and retain their hardness at speeds which almost instantly destroy the cutting edge of a steel tool. The tungsten may be still further increased to 40 per cent, and the alloy will retain its cutting qualities, and for turning cast iron this alloy answers even better than that containing 25 per cent. When the tungsten reaches 40 per cent or more, the alloy becomes so hard that it will not only scratch glass, but will readily scratch quartz crystal. A small drill made of this material drilled a hole through the wall of a glass bottle without the use of any liquid or other lubricant. A $\frac{3}{8}$-inch square cast bar, when ground to a suitable edge, was set in a tool holder attached to a lathe. The workman who had operated the lathe had been able to turn to form 26 cast-iron wheels in 10 hours with a steel tool of the same size. The stellite tool turned 49 of these wheels to form in the same time. The steel tool was ground fifty times during the operation, while the edge of the stellite tool was dressed slightly by a carborundum whetstone after its day's work was completed. A set of steel cutters, placed in the boring head of a cylinder-boring machine, was able to bore from 27 to 28 holes in 10 hours. These cutters were replaced by others made of stellite, which performed the work in 3 hours and 20 minutes, or a little more than one-third the time. Not only was the speed of the mill doubled, but the feed also, and notwithstanding this severe ordeal, the stellite cutters were only slightly worn, while it would have been necessary to regrind the steel cutters at least two or three times for the same service at slower speed. Some remarkable results were obtained in the turning of steel on the lathe. For example, a cylindrical bar of annealed nickel-chrome steel, about 2.5 inches in diameter, was placed in a lathe and turned with a steel tool at about as high a speed as the steel would permit without "burning." The steel tool was then replaced by one of stellite, and the speed at the same time increased to $2\frac{3}{4}$ its former speed. The stellite tool retained its edge under these severe conditions, and produced a shaving weighing 1.2 pounds in 30 seconds. Just what the effect of the alloy will be in machine-shop practice, is at present somewhat difficult to determine. In my opinion, however, it will not fully supersede high-speed steel in the machine shop, but in cases where rapid work is the main consideration, it will doubtless replace high-speed steel.

When molybdenum is added to a 15 per cent cobalt-chromium alloy, the alloy rapidly hardens as the molybdenum content increases, until the content of the latter metal reaches 40 per cent, when the alloy becomes exceedingly hard and brittle. It cuts keenly and deeply into glass and scratches quartz crystal with ease. It takes a beautiful polish, which it retains under all conditions, and on account of its extreme hardness its surface is not readily scratched. When 25 per cent of molybdenum is added to a 15 per cent chromium alloy, a fine-grained metal results, which scratches glass somewhat readily, and takes a strong, keen edge. Its color and luster are magnificent, and it will doubtless find a wide application for fine, hard cutlery. It can not be forged, but casts readily and its melting point is not abnormally high.

If carbon, boron, or silicon be added to any of the above alloys, the alloy becomes much harder, though the addition is not always desirable, since it tends to make the alloys more brittle.

If either tungsten or molybdenum be added to a cobalt-chromium alloy containing 25 per cent of the latter metal, the hardness of the alloy is rapidly increased. When the percentage of tungsten, for example, reaches 5 per cent, the alloy can be readily forged, and forms an excellent combination for wood-cutting tools, such as chisels,

pocketknives, etc. When molybdenum is added to the same mixture of chromium and cobalt, much the same effect is produced, though, generally speaking, a smaller quantity of molybdenum is required to produce a given increase in hardness. In some instances I have found it advisable to add both molybdenum and tungsten to the cobalt-chromium alloys. Generally, the color and luster of these alloys, after polishing, are brilliant, and they seem to resist atmospheric influences equally as well as the binary alloy of cobalt and chromium.

The comments of Albert R. Ledoux[1] upon Mr. Haynes's paper are worth repeating:

A prominent manufacturer of high-speed machinery, having seen the paper of Mr. Haynes, which was presented at the Cleveland meeting, informs me that after a test he has adopted stellite lathe tools throughout his plant. A comparative test gave the following results:

On phosphor-bronze—125 feet per minute, using superior high-speed steel; using stellite, 900 feet per minute.

On tool steel—80 feet per minute, using superior high-speed steel; using stellite, 133 feet per minute.

On steel seamless tubing—using superior high-speed steel, 100 feet per minute; using stellite, 400 feet per minute.

On cast iron—using superior high-speed steel, 100 feet per minute; using stellite, 200 feet per minute.

COBALT STEEL.

Cobalt has been tried many times as a steel alloy without making a notable improvement in the resulting steel. For instance, Guillet,[2] a French experimenter in steel, was quoted in this report for 1906 (pp. 520–521) as having found that "cobalt steels show no properties that are of industrial interest." However, there has recently come on the market a German steel known as "iridium steel," which contains cobalt and is of great industrial interest. The name is perhaps misleading, for, of course, it contains no iridium. Even were such a metal desirable in steel its price would be prohibitive.

The approximate average of several analyses of this steel, as given the writer by a steel manufacturer, was as follows:

Approximate average analysis of "iridium steel."

Cobalt	4.25	Manganese, Silicon, Sulphur, Phosphorus	Low
Tungsten	16.00		
Chromium	3.55		
Vanadium	.67		
Molybdenum	.80	Carbon	.60
		Iron, about	74

The same manufacturer stated that the steel would do 60 per cent more work than the best tungsten steel hitherto in use; and several months later, speaking not of this particular brand, but of the cobalt-tungsten steels, he increased this estimate considerably.

Somewhat similar steel is now being made in this country, but is believed to contain no molybdenum. The steel is reported, however, to be just as efficient. Ferrocobalt, carrying 70 per cent of cobalt, for the manufacture of steel is for sale at about $1.90 a pound for the contained cobalt.

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[1] Op. cit., p. 255.

[2] Guillet, Léon, Aciers spéciaux, Paris, 1905, vol. 2, pp. 113–114.

COBALT DRIERS.

Another use for cobalt which developed during the year and which may cause a considerable demand is its use as a drier of oils and varnishes, especially of soya bean oil and possibly of other cheap oils used as substitutes for linseed oil in paint. The cobalt must be in the tri-valent state to be useful as a drier, according to Dr. Toch.[1] Dr. V. P. Krauss[2] describes the manufacture and use of cobalt resinate, cobalt oleates and linoleates, cobalt oleo-resinates and cobalt tungates, Cobalt acetate is also used as a drier.

Dr. Krauss[3] quotes the following prices for cobalt driers:

	Cents a pound.
Cobalt linoleate	34
Cobalt resinate, precipitated	26
Cobalt resinate, fused	16
Cobalt tungate	6½
Cobalt acetate	95

Henry A. Gardner[4] thinks that cobalt and lead linoleate or cobalt and lead resinate act better than the single cobalt salt.

It was reported in the technical press[5] that Dr. H. T. Klamus was to undertake, at Kingston, experiments for the Canadian department of mines in making cobalt steel and in other means for the utilization of cobalt.

IMPORTS.

The imports for consumption of cobalt into the United States since 1901 have been as follows:

Cobalt oxide, ore, and zaffer imported into the United States for consumption, 1901–1912, in pounds.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1901	71,969	$134,208	1907	48,013	$74,849
1902	79,984	151,115	1908	219,098	17,677
1903	73.350	145,264	1909	12,132	11,096
1904	42,354	86,925	1910	14,935	6,352
1905	70,048	139,377	1911	602,454	59,151
1906	41,084	83,167	1912	791,242	83,080

Cobalt oxide was entered at a value of about 47 cents a pound; the selling price in this country, however, was about 80 cents. Cobalt of German manufacture in the form of powder was sold at $2 or a little less a pound, possibly $1.90. As already stated, ferrocobalt sold at $1.90 a pound for the contained cobalt.

[1] Toch, Maximillian, Soya bean oil for paint purposes: Jour. Soc. Chem. Industry, London, vol. 31, 1912, p. 10 (reprint).
[2] Cobalt driers: Original communications, Eighth Internat. Cong. Appl. Chem., vol. 12, 1912, pp. 127–131.
[3] Letter dated June 2, 1913.
[4] Soya bean oil and its most efficient driers; Paint, Oil, and Drug Rev., July 22, 1912, pp. 14–15.
[5] Canadian Min. Jour., Mar. 1, 1913, et al.

MOLYBDENUM.

By Frank L. Hess.

No commercial production of molybdenum is known to have been made in 1912, and no promising new deposits were reported to the Survey during the year. On the other hand, no new demand is known to have developed.

Molybdenum is used to a small extent in making tool steel (see analysis of steel under "Cobalt"); in making permanent magnets (containing about 6 per cent molybdenum); as supports for the lower end of tungsten filaments in incandescent electric lamps; for making ribbon to be used in small electric furnaces; and in chemicals, especially as ammonium molybdate, for the detection and determination of phosphorus in iron and steel. As ordinarily reduced, molybdenum is a dark bluish powder with a melting point so high that it can not be directly melted into a mass, but by putting it under great pressure, heating, and swaging it may be so compacted that it can then be drawn into wire which is tougher and stands much harsher usage than tungsten wire.

Prices for molybdenite, the native sulphide, are as uncertain as the production and demand and range from 20 to 40 cents a pound for molybdenite carrying 92 per cent or more of MoS_2.

Imports.—Molybdenum and ferromolybdenum valued at more than $200 a ton were imported during 1912 to the extent of 3.5 tons, valued at $4,670.

No record was kept of imports of molybdenum ore.

NICKEL.

By Frank L. Hess.

SOURCES OF PRODUCTION.

BLISTER COPPER.

No deposits in the United States were worked especially for nickel during 1912, and the only production made was a few tons of metallic nickel and a number of tons of nickel sulphate and nickel ammonium sulphate obtained as a by-product in the electrolytic refining of copper.

It has long been common knowledge that nickel, together with gold, silver, selenium, tellurium, and other elements, occurs in the blister copper sent from the smelters to the electrolytic refineries, but very little definite data have been at hand. For a number of years only the gold and silver were saved as by-products, but now other elements, platinum, palladium, nickel, bismuth, and more or less selenium are saved.

The firms working on the problem of saving the by-products naturally have not been very ready to make public the knowledge which they have gained at considerable expense. Recently, however, a valuable bit of information on the quantity of these elements in blister copper has been published by A. Eilers.[a] He gives a table showing the quantities of metals recovered as by-products from blister copper from various localities. In part the table is as follows:

Recoveries of rare metals and metalloids from 100 tons of blister copper.

Location of smelter.	Gold.	Silver.	Platinum.	Palladium.	Selenium.	Tellurium.	Bismuth.	Nickel.
	Ozs.	*Ozs.*	*Ozs.*	*Ozs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Garfield, Utah[b]	288.0	3,480	0.342	1.183	56.0	5.54	6.1	40.0
Steptoe, Nev.[c]	169.0	550	1.016	4.402	110.1	None.	0.33	64.0
Omaha, Nebr.[d]	360.0	23,090	1.825	6.486	26.6	67.1	18.6	944.0
Mountain, Cal.[e]	1,418.0	10,990	1.320	0.607	36.0	3.3	27.3	11.5
Tacoma, Wash.[f]	2,187.0	8,710	0.710	3.327	42.0	None.	5.7	770.0
Aguascalientes, Mexico[g]	482.0	67,300	0.416	0.226	170.0	None.	4.0	12.0
Cerro de Pasco, Peru[h]	170.0	9,900	0.319	0.589	13.7	None.	13.5	32.0
Mount Lyell, Tasmania[i]	464.5	7,205	0.624	1.374	42.0	None.	4.3	166.0

[a] Notes on the occurrence of some of the rarer metals in blister copper: Bull. Am. Inst. Min. Eng. No. 78, June, 1913, pp. 999–1000.

[b] The blister copper comes principally from the Bingham "porphyry" mines.

[c] From the "porphyry deposits" of the Nevada Consolidated Copper Co., at Ely.

[d] Principally from concentrated copper-lead mattes shipped from lead-silver plants of the Rocky Mountain region to the converters at the Omaha lead refinery.

[e] From ores of the Mountain Copper Co. at Iron Mountain, Shasta County, Cal.

[f] From Pacific coast and Alaska copper ores.

[g] From gold and silver ores low in copper, from all parts of Mexico.

[h] From copper and lead mattes from local deposits.

[i] From low-grade local copper deposits.

It is notable that the mixed ores from the Rocky Mountain region, mined mostly for gold and silver, yield nearly one-half of 1 per cent of metallic nickel. The ores smelted at Tacoma from Alaska and northern Pacific coast points are likewise rather high in nickel, nearly 0.4 per cent, but the others are all very much lower. It is claimed by one or two refineries that no nickel exists in blister copper refined by them, but it would be gratifying if figures could be obtained from all other smelters. It is notable that cobalt, if it occurs in the blister copper, is in such small quantity as not to be worth mentioning. However, the quantity present in the great Sudbury nickel deposits is very small, only 1 part of cobalt to 50 [1] of nickel. If present in this ratio in blister copper, cobalt would be scarcely noticeable in the copper carrying the smaller quantities of nickel.

There was produced in the refining of copper in the United States in 1912 an equivalent of about 328 tons of nickel, mostly in the form of nickel sulphate, but partly as metallic nickel. Much of the blister copper from which it is made is of foreign origin.

By far the greatest part of the nickel used in the United States still comes from Sudbury, Ontario, from the mines of the Canadian Copper Co., a subsidiary of the International Nickel Co., but there is now apparently substantial competition in the United States Nickel Co. of New Brunswick, N. J., a firm affiliated with Maison L. Ballande Fils Ainé, Noumea; the Société des Hauts-Fourneaux de Nouméa, Noumea, Caledonia; the Usines de Nickel de la Nèthe, S. A., Düffel, Belgium; and the Compagnie Navale de l'Océanie, which obtains its nickel from New Caledonia.

CANADIAN PRODUCTION.

John McLeish, chief of the division of mineral resources and statistics, gives the following details concerning the production of nickel in Canada in 1912: [2]

The mining and smelting of nickel-copper ores in the Sudbury district of Ontario was carried on with greatly increased output during 1912. The same companies were in operation as in previous years, viz: The Mond Nickel Co. and the Canadian Copper Co., operating mines and smelters, and the Dominion Nickel Co., developing and proving ore bodies. It is interesting to note that small shipments of nickel ore were also made from the Alexo mine at Kelso, in the Nipissing district. This ore was smelted at Victoria mines.

Considerable changes have been made in some of the details of smelting practice, although the general method remains the same, i. e., the ore is roasted, smelted, and converted to a Bessemer matte containing from 77 to 82 per cent of the combined metals, copper and nickel, the matte being shipped to the United States and Great Britain for refining. A portion of the matte made by the Canadian Copper Co. is used for the direct production of monel metal, an alloy of nickel and copper, without the intermediate refining of either metal.

The total production of matte in 1912 was 41,925 tons, valued by the producers at the smelters at $6,303,102, an increase of 9,318 tons, or nearly 20 per cent over the production of 1911. The metallic contents were copper 22,231,725 pounds, and nickel 44,841,542 pounds. The amount of ore smelted was 725,065 tons, which included 1,720 tons from the Alexo mine mentioned above.

The aggregate results of the operations on the nickel ores during the past four years were as follows in tons of 2,000 pounds:

[1] Barlow, A. E., Origin, geological relations, and composition of the nickel and copper deposits of the Sudbury mining district, Ontario, Canada: Reprint, Geol. Survey Canada, Ottawa, 1907, p. 228.

[2] McLeish, John, Preliminary report of the mineral production of Canada during the calendar year 1912, Mines Branch, 1913, pp. 12–13.

	1909	1910	1911	1912
Ore mined	451,892	652,392	612,511	737,584
Ore smelted	462,336	628,947	610,834	725,065
Bessemer matte produced	25,845	35,033	32,607	41,925
Copper content of matte	7,873	9,630	8,966	11,116
Nickel content of matte	13,141	18,636	17,049	22,421
Spot value of matte	$3,913,017	$5,380,064	$4,945,592	$6,303,102
Nickel contained in matte, etc.:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Exported to Great Britain	3,843,763	5,335,331	5,023,393	5,072,867
Exported to United States	21,772,635	30,679,451	27,596,578	39,148,993
	25,616,398	36,014,782	32,619,971	44,221,860

NEW CALEDONIAN PRODUCTION.

M. C. du Poizat is quoted by the Mining Journal, London,[1] as having given in Echo des Mines the following information concerning nickel mining in New Caledonia:

The total value of exportation of minerals from New Caledonia in 1912 did not exceed £560,000. The undermentioned figures show the ores and mattes shipped during the years 1911 and 1912:

	1911	1912	Value.
	Tons.	*Tons.*	*£. s. d.*
Nickel ores	120,059	72,315	1 7 2
Chrome ores	32,806	51,506	1 8 0
Nickel mattes	2,933	5,097	28 0 0

There are 800 nickel concessions, but only 40 are being exploited. The following are the principal companies, with their production in metric tons [2] during 1911:

	Metric tons.
Société le Nickel	47,000
Badoux & Metzdorf	16,000
Vieux & Talon	17,750
F. & G. Schmidt	10,780
Consolidated Mines	12,000
Bouteiller & Suaud	10,500
De Béchade	10,000
L. Ballande	8,000

The figures for 1911 and 1912 show progress when compared with those for 1908 and 1909. As regards nickel, the increase is the consequence of the growing consumption of the metal, which from 10,400 tons in 1901 has risen to 25,000 tons in 1912. The oxide of cobalt, arising as a by-product from the treatment of arsenides in the cobalt mining district, has so depressed the value as to cause the suspension of the New Caledonian mines.

The metallurgical installations of the island have been in successful operation for two years. The Société le Nickel at Thio has a 100-ton furnace, capable of running 30,000 tons of ore per annum. At Point Doniambo the Noumea works smelted in 1912 36,000 tons of 5 per cent to 6 per cent ore. The hydroelectric furnace at Tao is out of blast. These three establishments have exported mattes in tons as follows:

	Matte.	Percentage.	Metal.
Hautes-Fourneaux de Nouméa	3,314	45	1,491½
Société le Nickel	1,600	45	720
Société de Tao	103½	50	51⅔
Total tons of pure nickel			2,263⅙

[1] Vol. 101, May 10, 1913, p. 453.
[2] The metric ton is approximately 2,205 pounds, or roughly 1.1 short tons.

If the customs value of £28 per ton of nickel matte be accepted, the 5,000 tons exported in 1912 would have a total value of £140,000.

The Chrome Co. intend to construct a hydroelectric works of 15,000 horsepower for the purpose of manufacturing ferrochrome and ferronickel. The primitive methods of mining have been superseded by modern practice, which has already given favorable results. The want of employment, from which the colonists suffered, has been succeeded by an activity which promises to inaugurate an era of prosperity, assured by the increasing use of chrome and nickel in the manufacture of war material.

The Maison L. Ballande Fils Ainé and the Hauts-Fourneaux de Nouméa ship their low-grade mattes to the Usines de Nickel de la Nèthe in Düffel (Antwerp), Belgium, where the matte is bessemerized, silica being added to slag off the iron, and the grade of that part shipped to the United States is raised to 75 per cent nickel. The matte is shipped to New Brunswick, N. J., and there refined. It is sold in the form of shot, cubes, or plaquettes (blocks).

The ore occurs in New Caledonia as a silicate, and for its fluxing and reduction, soda ash, gypsum, sulphur, and coal are shipped to the island. Practically all supplies must also be brought in. The ore is mostly too low grade to be shipped at a profit, and the most economical process is therefore to reduce the ore to matte and ship the matte to a country with cheaper fuel and labor for refining. That part intended for sale in the United States is shipped as a high-grade matte, because in that form it is admitted free of duty, and, as with the International Nickel Co., only the refining is done here. Their ores carry very little copper (0.06 per cent copper in the nickel), and refining is a simpler process than with the Sudbury ores.

The company states that the shot averages 98 to 99 per cent nickel, with some nickel carbide; the cubes 99 to 99.10 per cent nickel; and that the placquettes are purer.

IMPORTS.

The imports of nickel for consumption into the United States from 1906 to 1912, inclusive, as reported by the Division of Statistics, Bureau of Foreign and Domestic Commerce, have been as follows:

Imports of nickel for consumption into the United States, 1906–1912, in pounds.

	Nickel, nickel ore, and matte, nickel oxide, alloys of nickel with copper, etc.[a]		Value of manufactured articles of nickel.	Total value.
	Quantity.	Value.		
1906	34,082,042	$1,867,568	$8,963	$1,876,531
1907	18,598,638	2,233,867	9,159	2,243,026
1908	16,825,291	2,487,605	9,980	2,497,585
1909	22,194,102	3,034,407	1,866	3,036,273
1910	32,373,251	4,213,079	14,759	4,227,838
1911	29,829,263	4,022,716	27,314	4,050,030
1912	46,317,078	5,724,431	37,536	5,761,967

[a] Includes only the nickel content of ore and matte. No ore is known to have been imported into the United States in 1911 or 1912.

The imports for 1912 were divided as follows:

Imports of nickel for consumption into the United States in 1912, in pounds.

	Quantity.	Value.
Nickel, alloys, pigs, bars, etc	223,161	$85,059
Ore and matte, nickel content (gross weight 33,088 tons)	46,093,040	5,638,456
Nickel oxide	877	916
Total	46,317,078	5,724,431

EXPORTS.

The United States refines much more nickel than it can use, so that although not an important producer it is a large exporter. Exports since 1901 have been as follows:

Exports of nickel, nickel oxide, and matte from the United States, 1901–1912, in pounds.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1901	5,869,655	$1,521,291	1907	8,772,578	$2,845,663
1902	3,228,607	924,579	1908	9,770,248	3,297,988
1903	2,414,499	703,550	1909	12,048,737	4,101,976
1904	7,519,206	2,130,933	1910	15,244,937	4,704,088
1905	9,550,918	2,894,700	1911	[a]25,099,586	8,283,777
1906	10,620,410	3,493,643	1912	[a]25,815,016	8,515,332

[a] No nickel matte is known to have been exported during 1911 or 1912.

PRICES.

The price during the year varied from about 35 to 50 cents a pound, depending on quantities. The lowest price of about 35 cents is said to be made with large users, who sign exclusive contracts for a term of years with an agreement not to resell.

USES.

The principal use for nickel is in making nickel steel, a tougher, more shock-resistant steel than carbon steel. Certain compounds of nickel and iron known as invar have an almost negligible coefficient of expansion and are used in making accurate tapes, pendulums, watch springs, and other instruments of precision. After its use in steel, however, the largest quantity of nickel is used in the nickel-plating industry in the form of nickel anodes, nickel sulphate, and nickel ammonium sulphate. It is also largely used in the making of German silver. A use which seems to be of much commercial value, though it probably does not absorb a great deal of metal, is in the hydrogenation of oils. By this process cottonseed oil is changed to a solid and as such is largely used as a cooking fat. Many patents have been issued covering the utilization of oils and fats from sewage, the deodorization of petroleum, and the changing of water gas, Riche gas, and other gases into methane through the use of finely divided nickel as a catalyzer.

TANTALUM.

By Frank L. Hess.

So far as reports to the United States Geological Survey show, no tantalum minerals were mined or sold for tantalum in this country during 1912.

As stated in former reports, the chief use of tantalum has heretofore been for making filaments for incandescent electric lamps. Since the great improvement of the tungsten lamp through the making of drawn-wire filaments, tantalum has suffered severely in the competition. For most uses the greater efficiency of the tungsten lamp (0.79 to 1.5 [1] watt per candle as compared with 2 to 2.3 watts for the tantalum lamp) and the better quality of light given by the tungsten lamp are driving the tantalum lamp out of the market.

Tantalum is remarkably resistant to oxidization at ordinary temperatures, and to the action of acids and alkalis. It therefore seems to hold considerable possibilities for use in surgical instruments, pens, and chemical apparatus. Its reduction from its ores is, however, difficult, particularly its separation from columbium, which nearly always accompanies it. The price is very high, 59.4 cents a gram (15.4 grains), almost as much as gold (66.4 cents a gram).

It is isolated from tantalite (columbite low in columbium) and mangano-tantalite, obtained largely from Western Australia. The latter mineral is obtained only from Western Australia, but tantalite comes also from the Black Hills of South Dakota and Canon City, Colo. Other minerals carrying smaller percentages of tantalum, such as columbite with lower percentages of tantalum, samarskite, blomstrandite, hatchettolite, and strüverite are at present unused, but all are rare minerals. However, should there be a keen demand at the present price, it is probable that considerable quantities could be found and that the lower grade minerals would be worked. Strüverite, for instance, has been found in such quantity in the placer tin deposits of the valley of Sebantun River, near Salak North, Federated Malay States, that the placer could not be worked [2] profitably for tin, and it is possible that comparatively large quantities of other tantalum minerals might be found if there were a regular demand. As it is, there is neither steady demand nor production. One of the most serious difficulties for sellers is that under present conditions they must pay for analyses (as much as $10 per analysis) for every lot of ore sold, as it is generally handled by brokers who do not have

[1] Bull. Eng. Dept. Nat. Elec. Lamp Assoc., Nos. 8 D, 11 A, and 18 A, Cleveland, 1912 and 1913; also, Bull. Nos. 5, 5 A, and 5 B, 1907 and 1909.

[2] Strüverite, a rare tantalum mineral from the Federated Malay States: Bull. Imp. Inst., vol. 9, 1911, pp. 354–355.

chemists in their employ, and the profit on small sales is not sufficient to pay to have analyses made. This is burdensome to the miner, and were the demand sufficient would probably be eliminated.

The only firm now known to isolate and work tantalum is the Siemens & Halske A. G., Charlottenburg, Berlin, Germany, and the principal research work on the metal has been done in their laboratories, but an investigation of tantalum for use as electrodes in electro-analysis has been published by O. Brunck. He describes his results as follows: [1]

The price of platinum has steadily risen in the last decade and has reached a height which makes it extremely difficult for the chemist to obtain the indispensable apparatus made of this metal. A great part of the blame for this may be attributed to the jewelry industry, which uses very considerable quantities of the limited supply put on the market. From an esthetic point of view platinum is far inferior to gold and silver. The prominent physical and chemical properties that make it so valuable for the chemist, and necessitate its use for technical purposes in no way influence its use for ornaments. It is in demand for this because it is costly. Platinum did not become the fashion until its price outstripped that of gold.

As there is no prospect that the price of platinum will fall appreciably, science and industry are trying to find a substitute for the costly metal. It is extremely improbable that a substance will be found that can in all cases replace platinum; but it is highly desirable to find a substitute even for a part of its uses, so that the valuable material hitherto used for these purposes may be available for those in which it is indispensable. Thus quartz glass, which is now put on the market at a moderate price, offers a substitute for platinum for many purposes, although not a perfect one. It is entirely resistant to all acids except hydrofluoric acid, and is insensible to sudden changes of temperatures, but has the disadvantage of being fragile and a poor conductor of heat. Chemical apparatus have been made, also, of an alloy of 90 per cent gold and 10 per cent platinum. This compound is harder and more compact than gold, but somewhat more difficult to work than gold or platinum. It might be a perfect substitute for the latter if its melting point were higher; but as this is only a little higher than that of gold, crucibles and basins may be melted through over an ordinary Bunsen burner. Nevertheless, the field of this alloy's usefulness is tolerably large, but the saving, unfortunately, is small. On account of the higher cost of shaping, the price of apparatus made from the alloy is about two-thirds the cost of the platinum equipment.

Very recently the firm of Siemens & Halske proposed tantalum, which was originally used only for metal filament lamps, as a substitute for platinum in certain uses, and has put on the market various apparatus and instruments of this formerly very expensive metal at a price of 2.50 marks (59.4 cents) a gram (15.4 grains), including cost of shaping. In temperatures below 200° C. tantalum is an altogether noble metal, is attacked neither by the oxygen of the air nor by acids, with the exception of strong hydrofluoric acid, not even by aqua regia. Although entirely resistant to watery solutions of alkalies, the compact metal is destroyed by melting alkalies. When heated in the air tantalum begins to oxidize considerably at red heat, and at a higher temperature burns to white tantalum oxide, though, as is well known, in a vacuum it can stand the highest white heat. Tantalum found immediate acceptance as a material for surgical instruments, especially dental instruments. Tantalum basins for chemical use are, up to the present, however, the only form in which the metal is used in chemical laboratories. The sentitiveness of the metal to oxygen at the higher temperatures, and also to hydrofluoric acid, hinders its general adoption as a substitute for platinum.

The properties of tantalum, as just described, seemed to me to make it altogether suitable as an electrode material in the electrolysis of metal salts, especially in electro-analysis, a supposition completely verified by experiments. The electrodes prepared for me for experimental purposes by Siemens & Halske, A. G., had the form and size of the Winkler wire gauze electrodes and spirals in general use. For greater convenience of manufacture the cathode was made of a much perforated sheet of tantalum; in place of this a net electrode of tantalum wire was naturally used for ordinary purposes.

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[1] Brunck, O., Tantalelektroden, Chem. Zeitung, Clöthen, vol. 36, 1912, pp. 1233–1234.
An abstract of this article has been published by the firm of Siemens & Halske, A. G., Charlottenburg Incandescent Lamp Works, entitled "Das Tantalmetall und seine Verwendung in Industrie und Wissenschaft." Compare also von Pirani, Chem. Zeitung, 1912, p. 1096.
Statement from the Chemical Laboratory of the Academy of Mines at Freiberg, Saxony.

The experiments proved that in all cases tantalum may be substituted for platinum as a cathode material, but it is not suitable for anode material without special treatment. In the electrolysis of metal salt solutions, for instance, the anode is covered in a very short time, even before appreciable quantities of metal have been deposited on the cathode, with a close-clinging layer of dark-blue tantalum oxide of metallic luster, which conducts so poorly that a measurable current no longer passes through the electrolyte.[1] The increase in weight of the anode amounts to only a fractional part of a milligram, the quantity of tantalum oxide, therefore, to only a few milligrams. The blue oxide is insoluble in all acids, including aqua regia, and is probably Ta_2O_4. The oxide layer can be removed by rubbing the anode with emery paper. If one does not wish to give up the use of tantalum as an anode material, and work with a tantalum cathode and platinum anode, the tantalum anode is coated with a thin layer of platinum, this being easily done by electrolysis. A coating of a few centigrams of platinum is quite sufficient. It is best to use for the anode tantalum wire plated with platinum by a process patented by Siemens & Halske.

Silver, copper, platinum, and cadmium can be deposited quantitatively and in perfect form on the tantalum cathode from acid sulphate solution, zinc from alkaline zincate solution, nickel and cobalt from ammoniacal sulphate solution, and tin and antimony from their sulpho-salt solution. The precipitated metals can be easily removed from the cathode with acid, and the tantalum sheet will retain its original luster and weight. As a cathode material tantalum has some advantages over platinum. For example, zinc and cadmium show no inclination to alloy superficially with the tantalum, so that the coppering or silvering of the cathode that is necessary with platinum may be dispensed with here. The insensibility of tantalum to aqua regia permits the precipitates of platinum and gold to be readily resolved. In other cases it is also advantageous to be able to dissolve the metals with aqua regia, or, better, with hydrochloric acid with the addition of a little nitric acid, if it is desirable (as, for example, in the separation of an electrolytically deposited mixture of nickel and cobalt) that the metals should be present as chlorides. Another advantage of tantalum over platinum is its greater toughness and hardness, these properties rendering the electrodes less liable to bending.

The difference in price is considerable, the price of tantalum being only 40 per cent of the price of platinum. In addition, the specific gravity of tantalum is only about 16.6, as against 21.48 in platinum, and because of the greater stiffness of the metal the tantalum electrodes may be made thinner. Thus there is an economy in weight of about 30 per cent. The difference in price of tantalum and platinum electrodes is very considerable and is of much importance if, as in metallurgical laboratories, a great number of electrolytic determinations are made at the same time, compelling the investment of a considerable sum in platinum electrodes.

Tantalum electrodes are not affected in alkali electrolysis, so that it may be substituted for platinum in the various types of bleach electrolysis. In other electrochemical operations, also, tantalum may be used as electrode material. The general use of tantalum in electrolyses would leave for other purposes, to which it is now indispensable, the quantities of platinum hitherto consumed in electrodes.

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[1] See also Schulze, G., Ann. Phys., 1907, vol. 23, p. 226.

TIN.

By Frank L. Hess.

GENERAL CONDITIONS.

Tin mining in the United States is a matter of little consequence when compared with the production of tin in other countries or with the output of many other minerals in this country. The production of secondary tin is immensely more important in this country than is tin mining.

The York Dredging Co.'s dredge on Buck Creek, 15 miles east of Cape Prince of Wales, Alaska, had a fairly successful season, getting out 130 tons of stream tin, carrying 68 per cent tin and valued at $124,800.[1] A small quantity of stream tin was sluiced from Tofty Gulch, near Hot Springs in the Tanana Valley.

Nothing is known to have been done upon the other tin deposits in the United States.

As usual the United States was the greatest user of tin and imported great quantities of the metal. The United States Steel Corporation is said to be the largest user of tin in the world and keeps its own buyer at Singapore. A small quantity of ore was imported and was smelted by Marks Lissberger & Son (Inc.). Since the United States uses such large quantities of tin it seems probable that in time the domestic manufacturers may be competitors for the tin ores of Bolivia, bringing them to this country for smelting. At present the Bolivian ores are mostly sent to Europe for reduction on account of the lack of fuel in Bolivia. The smelting of Bolivian ore has been successfully performed in this country, and there seems to be no reason why it should not be done on a large scale if the ore becomes available. No effort is known to have been made to divert the flow of barilla (concentrates) this way. It is possible that if vessels sail from Atlantic ports to Pacific ports near Bolivia by way of the Panama Canal tin ore may be brought back, saving for this country a part of the profit on tin which now goes abroad.

[1] Figures published with the express permission of the York Dredging Co.

The world's tin deliveries for 1912, which approximate both consumption and production, as compiled by the New York Metal Exchange, were as follows:

Tin deliveries, 1911 and 1912, in short tons.[a]

	1911	1912
London deliveries	17,643	20,823
Continent of Europe	24,671	29,820
Cornwall (production)	5,936	6,160
Bolivia (shipments)	25,312	23,744
South Africa (shipments)	3,248	3,472
China (shipments)	1,680	2,576
United States (receipts)	51,892	57,557
	130,382	144,152
(Deduction of Straits, etc., from Continent and English, Bolivian, etc., arriving in the United States)	6,832	9,598
	123,550	134,554

[a] Metal Statistics, 1913, New York, 1913, p. 171.

The Federated Malay States (referred to as the Straits or Straits Settlements) produce by far the greatest quantity of tin and nearly all of it comes from alluvial deposits, only a little being obtained from veins. During 1912, the shipments amounted to 66,100 short tons, against 62,126 tons in 1911.

Banka auction sales in Holland amounted to about 17,920 short tons in 1912 and 16,800 tons in 1911. Bolivia was by far the largest producer of lode tin.

PRICES.

Tin prices in New York, based on Straits tin, from 1908 to 1912, were as follows:

Average monthly prices, in cents per pound, of Straits tin in New York.[a]

	1908	1909	1910	1911	1912
January	27.53	28.13	32.74	41.39	43.24
February	29.10	28.30	32.96	42.83	43.46
March	30.66	28.74	32.49	40.76	42.86
April	31.86	29.48	33.02	42.20	44.02
May	30.09	29.16	33.18	43.10	46.12
June	28.13	29.32	32.84	46.16	47.77
July	29.20	29.17	33.04	42.96	44.75
August	29.97	30.04	34.10	43.45	45.87
September	28.88	30.35	35.23	39.98	49.18
October	29.47	30.50	36.63	41.21	50.11
November	30.40	30.90	36.68	43.13	49.90
December	29.18	33.06	38.28	44.97	49.90
Average	29.54	29.76	34.27	42.68	46.43

[a] Op. cit., p. 187.

IMPORTS.

According to figures compiled by the Division of Statistics, Bureau of Foreign and Domestic Commerce, the United States during the year 1912 imported for consumption 58,016 short tons of tin, valued at $50,372,478; tin foil, valued at $684; all other manufactures of tin, $381,259; and black oxide of tin or cassiterite (including 8.4 tons "tin ore"), 34 tons, valued at $14,534. The total value of tin imports amounted to $50,768,955. The imports of tin for consumption were the largest on record and amounted to about 43 per cent of the world's production.

The imports of metallic tin for consumption into the United States for the last 10 years have been as follows:

Tin imported and entered for consumption in the United States, 1903–1912, in short tons.[a]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	41,567	$22,265,336	1908	41,267	$23,923,560
1904	41,472	22,356,895	1909	47,662	27,558,546
1905	44,188	26,316,023	1910	52,528	33,913,255
1906	50,477	37,447,315	1911	53,527	43,346,394
1907	41,257	32,074,263	1912	58,016	50,372,478

[a] These figures do not include the tin contained in imported ore, tin foil, or other manufactures.

SECONDARY TIN.

Concerning the recovery of tin from secondary sources in 1912, J. P. Dunlop, of the United States Geological Survey, says:

There were no domestic tin ores smelted in the United States in 1912, though some tin concentrates were shipped from Alaska to Great Britain for treatment and a small quantity of foreign tin ore was smelted in New York. This condition makes secondary tin an important factor in supplying domestic consumption. The secondary tin recovered in 1912 was equal to 26.6 per cent of the tin imported as metal or as oxide into the United States during the year. Secondary tin recoveries increased from 14,706 short tons, valued at $12,353,040, in 1911, to 15,401 tons, valued at $14,301,368, in 1912. The quantity recovered as tin was 8,333 tons and that in alloys and chemical compounds 7,068 tons. The value of the recovered tin is arbitrary and is based on the yearly average price given by the "American Metal Market."

The recovered tin includes the tin content of products made by several plants from tin scrap. These included some tin oxide, putty powders, etc., but consisted mainly of tin chloride. The production of these compounds is calcualted as metal and not separately stated, in order to avoid disclosing confidential information. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin. Two forms of tin chloride are handled commercially—stannic and stannous salts. Stannic chloride is usually sold either as a water solution, called bichloride of tin, or as an anhydrous sirupy liquid, termed tetrachloride of tin, and is used principally in the silk industry. Stannous chloride is sold in the form of crystals and is used in dyeing and calico printing.

Most of the tin oxide, tetrachloride, and other products were made from clean tinplate clippings or from tin liquors left in dyeing or weighting silks. The dry chlorine process was used to recover the tin from the clippings in some places. In others reverberatory furnaces were used to remove the tin coating, and a large quantity of tin was recovered in the form of a tin powder by the electrolytic treatment of clean scrap, the powder being sent to secondary smelters. The largest recoveries of tin were made from the scruff and drosses that occur in making tin and terne plate, and amounted to over 5,000 tons. The recovery of tin from block tin pipe, tin foil, and old tin cans was relatively small. Only one firm reported using old tin containers, from which the tin and solder were first sweated and the black plate remelted to make sash weights. Two years of high prices for tin have failed to bring about any increase in the recovery

from used tin cans, and there seems to be no present prospect of any conservation of the large quantity of tins used for tin plate, which now finds its way to the unsightly dump pile.

The pricipal alloys in which secondary tin was recovered were babbitt and other bearing metals, bronze, solder, pewter, and electrotype metal. The increase of tin in alloys was small, probably because the high price for the metal the last two years has caused the use of less tin in bearing metals and solder.

As ascertained by Mr. Dunlop, the production of secondary tin in the United States during the last three years has been as follows:

Production of secondary tin in the United States in 1910–1912, in short tons.

Year.	Recovered as tin.	Recovered in alloys.	Total tin.	Value.
1910	7,217	6,686	13,903	$9,481,800
1911	7,749	6,957	14,706	12,353,040
1912	8,333	7,068	15,401	14,301,368

TITANIUM.

By Frank L. Hess.

The American Rutile Co. was the only producer of rutile in the United States in 1912. At its mine and mill at Roseland, Nelson County, Va., this company produced 275 tons of concentrates, carrying from 80 to 85 per cent of titanic oxide. The principal impurity is iron oxide, carried in an iron-rich mineral, which from its black color is supposed to be ilmenite. The ilmenite is easily separated from the rutile by an electromagnet and 100 tons of such purified concentrate were produced, which carried 94 per cent or more of titanic oxide. The separated material carries from 50 to 60 per cent of titanic oxide and as much as 42.3 per cent of iron oxide. It is especially adapted for making ferrotitanium. The company allowed its plant to remain idle during 1911 and did not begin operations in 1912 until June. During the year a Wetherill magnetic separator was put into operation and a pulverizer was added.

The company works ore of two sorts, phases of the same rock mass. One phase is composed mostly of feldspar, quartz, and rutile. The other contains considerable hornblende and ilmenite besides the constituents named. From the first phase a light red rutile, very free from iron, is obtained, which concentrates to more than 94 per cent of titanic oxide. The rutile obtained from the other phase of the rock is somewhat darker colored than that from the first phase.

The company's product is sold for making ferrotitanium for use in the manufacture of steel, in electrodes of the "magnetite" arc lamp, in the ceramic trade, and in dyeing leather and textiles. Prices range from $30 to $160 a ton, according to percentage of titanic oxide and quantity. Pulverized rutile and extra pure grades sell for higher prices.

Considerable prospecting for titanium oxide was done near Magnet, Ark., where it occurs as brookite, rutile, and octahedrite in connection with a nepheline syenite. The minerals are all black, and many fine splendent crystals are found. No deposits of commercial importance are known to have been developed.

Imports during the year amounted to 26 short tons of ferrotitanium, valued at $7,631, compared with 51 tons, valued at $22,700 in 1911. Some rutile was exported.

During the year 141,773 long tons of steel rails treated with ferrotitanium were rolled,[1] as against 152,990 long tons in 1911 and 256,759 long tons in 1910. Other alloy rails, manganese, copper, and nickel, amounted to 7,494 tons, against 999 tons in 1911 and 565 tons in 1910.

[1] Statistical Bull. No. 2, Bur. Statistics Am. Iron & Steel Inst., N. Y., Feb. 28, 1913, p. 2.

TUNGSTEN.

By Frank L. Hess.

GENERAL CONDITIONS.

The production of tungsten ore in the United States during 1912 was equivalent to about 1,330 short tons carrying 60 per cent of tungsten trioxide, and was valued at $502,158; besides which a smaller quantity was mined and not marketed. The output for 1912 was larger than that for 1911, when 1,139 tons, valued at $407,985, were produced, but amounted to little more than two-thirds of the output of 1910, when 1,821 tons, valued at $832,992, were marketed.

Alaska.—No production of tungsten was made by Alaskan mines during 1912, but prospecting and development work was pushed on the Crim, Randt & O'Brien tin claims on Cassiterite Creek, a tributary of Lost River, 100 miles northwest of Nome. The tungsten mineral is wolframite, with a small quantity of scheelite.

Scheelite was reported as having been found in the Alaska Range, but was not thought to be in commercially valuable quantity.

Arizona.—As in former years, a few tons of high-grade hübnerite was produced in 1912 from the dry placers 4 or 5 miles north of Dragoon. A little ore was also taken from the quartz veins.

A few tons of high-grade ore were mined from the hübnerite-bearing veins near Arivaca and shipped to Denver for milling. The construction of a railroad from Tucson to Calabasas has made the transportation problem very much easier than it had been. The distance from the claims in the Las Guigas Mountains to Arivaca Junction is about 24 miles, whereas the distance to Tucson, formerly the nearest railroad station, is about 70 miles. During the year all the claims were bonded to a company which hoped to work them on a larger scale.

Near Cave Creek, 31 miles north and a little east of Phoenix, a nearly black wolframite is reported to occur in an old prospect, accompanied by copper minerals, bismuth, and a mixture which is possibly bismuth carbonate, tungstite, and a little malachite. No work is known to have been done for tungsten on this deposit.

Near Columbia, 35 miles northwest of Cave Creek and about 65 miles from Phoenix, preparations for the work of reconcentrating the old tailings of the Tip Top silver mine were begun during the year. It is stated that there is a considerable quantity of both wolframite and silver in the old tailings.

Considerable development work was done on the Williams & Pittman hübnerite claims near Owens on the Big Sandy, and some ore was extracted but none was shipped during the year.

A number of tons of scheelite were shipped by the Cody-Dyer Mining & Milling Co. from the Old Hat district, near Oracle, 40 miles north of Tucson. The scheelite accompanies gold ore. Wolframite has been reported from this general locality a number of times, but nothing is known of the details of its occurrence.

California.—The only extensive production of tungsten ores in California was as usual that from the scheelite mines at Atolia, San

Bernardino County. The Atolia Mining Co., which controls most of the known deposits, was the largest individual producer of tungsten ores in the United States during the year. The Papoose, which was at one time the company's richest mine, has ceased to be productive, but the East Union No. 1 mine was continued downward below the 600-foot level and is still productive. A number of veins on other claims are also being operated.

A little scheelite was mined from the Waldemar claim in the Stringer district, between Atolia and Randsburg. The mine is about 1½ miles southeast of the latter place.

On the gulch crossing the west side of the old Baltic claims a company put in machinery for washing the gravel to extract both gold and scheelite, but no extraction was made during the year. Water is used in the process, and must necessarily be shipped in or be pumped a considerable distance.

A discovery of scheelite was made on the west side of the Rand Mountains 3 or 4 miles southwest of Randsburg, and a little ore was taken out and milled but none was sold. The claim is in Kern County.

A little milling was done at the Red Dog Mill in Johannesburg, but as heretofore by far the largest part was done by the Atolia Mining Co.

In the Clarke Mountains, near Ivanpah, San Bernardino County, considerable development work was done during the year and some ore of comparatively low grade was shipped. It could not be concentrated locally as there is no mill in the district. The ore is a wolframite with a subsidiary quantity of scheelite.

Discoveries of tungsten deposits were made during the year at Grass Valley, near Weldon, and in Jawbone Canyon. The last two localities are in Kern County. At Grass Valley the Union Hill Mining Co. ran a crosscut from their 300-foot level to the 400-foot level of the old Lucky vein and rediscovered scheelite in this old gold mine in which the first discovery of scheelite in California was made. The scheelite occurs in bunches with gold in the main vein and also in stringers of pure or nearly pure scheelite cutting the slate country rock at various angles. The scheelite is creamy to light brownish in color. A small quantity has been sorted by hand in the course of gold mining.

In specimens received from Mr. Arthur K. Doe, secretary of the Union Hill Mining Co., small quantities of galena, pyrite, sphalerite, and native gold occur in the quartz and are partly inclosed by the scheelite at the junction of the scheelite and the quartz.

This occurrence of scheelite was noted by Henry G. Hanks, of California, in the Fourth Annual Report of the State mineralogist in 1884 (p. 353), as in a gold mine on Howard Hill, but the mine had then been closed for a dozen years.

Scheelite has been found in Kelsey Valley, near Weldon, Kern County, and is said to occur in a granitoid country rock. The specimens sent to the Survey carry much epidote, and less quantities of hornblende, garnet, pyroxene, sphene, quartz, hydrous iron oxide, and oxidized copper minerals, with disseminated particles of scheelite, and strongly suggest a contact metaphoric deposit. The deposit is reported to be largely covered with débris and its extent is uncertain.

In Jawbone Canyon, opening into the Cane Lake bolson (totally inclosed valley), a deposit carrying both wolframite and gray scheelite

has been found about 7 miles from Cinco, a siding on the Owenyo branch of the Southern Pacific Railroad. Besides the two tungsten minerals, specimens sent to the Survey contain much muscovite and less quartz, some oligoclase, and probably other minerals. The specimens are pegmatitic in character. The vein is reported to cut a very micaceous granitoid rock.

Colorado.—The continued low prices for tungsten ore were severely felt in the Boulder field which, however, was as usual, the largest producing district of the United States. As is now well known the tungsten mineral mined in this district is ferberite (iron tungstate) and the district is unique in being the only one in the world which produces large quantities of this mineral. The production was equivalent to about 775 tons of ore carrying 60 per cent WO_3.

The Primos Mining & Milling Co. and the Wolf Tongue Mining Co. were still much the largest producers. The former company works its own mines which are situated near Nederland and at Sugar Loaf (Gordon Gulch). Its Conger mine situated about a mile northwest of Nederland has up to date been the richest mine of the district. The vertical shaft which was begun two or three years ago was deepened somewhat and is reported to have cut an excellent vein heretofore unknown. An electric tramway to carry ore from the Conger mine to the Lakewood Mill, was nearly completed during the year.

The Wolf Tongue Mining Co. worked its properties entirely by the leasing system, but owing to the comparatively low price of tungsten during the greater part of the year not much work was done.

The company adopted a new policy during the year and furnished its lessees electric hoists without charge, they, however, to pay for the current used. The company also paid a certain amount for each foot of development work done. These terms, with an improvement in the price toward the end of the year, induced a number of lessees to begin work. The company leased the property of the Tungsten Mining, Milling & Exploration Co. lying between Nederland and Beaver Creek, and intends to operate it by subleasing.

The last-named company did no mining during the year, but the Ardourel & Smith mill, situated beside Beaver Creek on its property, operated on tailings of the Wolf Tongue Mining Co.

On the "Rogers Patent," a considerable tract of land lying northeast of Nederland, on the ridge between Middle Boulder and North Boulder creeks, Eugene Stevens and a number of lessees worked 27 veins.

In Carrie Nation Park, 5 miles northeast of Nederland, the Colorado Tungsten Mines Co. built a mill stated to have a capacity for treating 50 tons of ore a day. The mill is equipped with Monell concentrating machinery. The company not only milled its own ore but did custom milling as well.

Only those companies making the largest production during the year have been mentioned. A number of other companies and individual operators also produced some ore in the district.

Six mills treated ore during the year. Those of the Primos Mining & Milling Co., the Wolf Tongue Mining Co., Ardourel & Smith, and the Colorado Tungsten Mines Co. have been mentioned. Besides these the Eureka mill, at Boulder, operated on ores from the district, and the Tungsten Mines Co.'s mill, on Beaver Creek, half a mile below the Ardourel & Smith mill, operated a short time before July 1.

So far as can be learned the various buyers paid about the same price for ores, and $6 per unit for ore carrying 60 per cent WO_3 was the prevailing price during most of the year, but higher prices were sometimes paid for particular lots. The price was raised about December 1 to $7.50 per unit for 60 per cent ore, but of course lower prices were paid for ore carrying smaller percentages.

The following schedules of prices, issued by the Wolf Tongue Mining Co., show the variations in price with different grades of ore, and though these variations are not always the same, either with this or other companies, they are fairly representative.

Schedules of the Wolf Tongue Mining Co. for tungsten ores, 1912.

Percentage tungstic acid (WO_3).	Price Jan. 1.		Price Dec. 1.	
	Per pound, in cents.	Per short ton.	Per pound, in cents.	Per short ton.
1	5	$1.00	5	$1.00
2	5	2.00	5	2.00
3	8	4.80	11	6.60
4	10	8.00	13	10.40
5	12	12.00	15	15.00
6	13	15.60	16	19.20
7	14	19.60	17	23.80
8	15	24.00	18	28.80
9	16	28.80	19	34.20
10	17	34.00	20	40.00
11	18	39.60	20	44.00
12	18	43.20	20	48.00
13	19	49.40	20	52.00
14	19	53.20	20	56.00
15	20	60.00	23	69.00
16	20	64.00	23	73.60
17	21	71.40	23	78.20
18	21	75.60	23	82.80
19	21	79.80	23	87.40
20	22	88.00	25	100.00
21	22	92.40	25	105.00
22	22	96.80	25	110.00
23	22	101.20	25	115.00
24	22	105.60	25	120.00
25	23	115.00	26	130.00
26	23	119.60	26	135.20
27	23	124.20	26	140.40
28	23	128.80	26	145.60
29	23	133.40	26	150.80
30	23	138.00	27	162.00
31	23	142.60	27	167.40
32	23	147.20	27	172.80
33	23	151.80	27	176.20
34	23	156.40	27	183.60
35	24	168.00	28	196.00
36	24	172.80	28	201.60
37	24	177.60	28	207.20
38	24	182.40	28	212.80
39	24	187.20	28	218.40
40	25	200.00	29	232.00
41	25	205.00	29	237.80
42	25	210.00	29	243.60
43	25	215.00	29	249.40
44	25	220.00	29	255.20
45	26	234.00	30	270.00
46	26	239.20	30	276.00
47	26	244.00	30	282.00
48	26	249.60	30	288.00
49	26	254.80	30	294.00
50	27	270.00	32	320.00
51	27	275.40	32	326.40
52	27	280.80	32	332.80
53	27	286.20	32	339.20
54	27	291.60	32	345.60
55	28	308.00	34	374.00
56	28	313.60	34	380.80
57	28	319.20	34	387.60
58	29	336.40	34	394.40
59	29	342.20	34	401.20
60	30	360.00	37½	450.00

Idaho.—The production of hübnerite concentrates from the Blue Wing district on Patterson Creek, Lemhi County, was again less than the operators had hoped to make during the year. The Idaho Tungsten Co. spent most of the year developing its mine, building a new mill, and constructing a flume for power. The mill was completed in October, and the production of concentrates commenced. Some concentrates were sold during the year. Development work was also prosecuted on other properties in the neighborhood.

A discovery of wolframite in the Lava Creek mining district, Blaine County, was reported to the Survey by Robert N. Bell, State mine inspector. The wolframite is said to be in a quartz vein at the contact of limestone and granite, near the eastern termination of the Sawtooth Range, at an altitude of 8,500 feet. It is between the heads of Fish and Lava creeks. The vein shows wolframite in small blades at several points in a distance of 500 feet.

Nothing was done with the scheelite deposits at Murray.

Nevada.—According to various short items appearing in the press, a mill erected at Round Mountain, Nev., by the Round Mountain Tungsten Mining & Milling Co. in the latter part of 1911 was acquired by the Shoshone Tungsten Mining Co. in 1912. This company reports the mining of a considerable tonnage of ore, but only a small quantity was concentrated and marketed.

At the mines of the United States Tungsten Co., at Hub, near Osceola, the local papers reported the prosecution of development work, but no concentrates were made. Some concentrates made in 1911 were sold.

No production was reported from the other deposits of the State.

New Mexico.—A small quantity of high-grade hand-cobbed hübnerite was shipped from the Victorio district, near Gage, Luna County, by Dr. M. M. Crocker. So far as was reported to the Survey, this was the only tungsten ore sold in the State during 1912.

Margarito Romero, who has a scheelite-bearing vein on Hermit Mountain northwest of Las Vegas, was engaged during the year in driving an adit to cut the vein at a considerable depth.

Texas.—A small specimen of black wolframite was sent to the Survey from the property of Ed. Kiam in the Sierra Diablo district, Culberson County. The specimen also carries small aggregates of what appears to be a mixture of scheelite and malachite.

Washington.—No tungsten ore or concentrates are known by the Survey to have been shipped from Washington during the year, though some work was done on the various deposits, especially on those on Cathedral Mountain, 35 miles northwest of Loomis.

Other States.—A discovery of wolframite in the Wasp No. 2 mine on Yellow Creek, near Lead, S. Dak., was reported during the year, but no production was made. Only a small amount of prospecting for tungsten was reported, though wolframite has been found at many places in the southern part of the Black Hills.

In Utah scheelite was discovered in mine dumps at several places in the Deep Creek Mountains by B. S. Butler, of the United States Geological Survey, but the importance of the mineral at these places is unknown. Scheelite was said to be found near Antique,[1] Panay Island, Philippine Islands, during the year, but the find was not corroborated.

[1] Min. and Sci. Press, Dec. 14, 1912, p. 769.

A little prospecting for scheelite was reported from the Sheepeater district near Livingston, Mont., but apparently little was done in the Potosi district, Madison County, 8 miles southwest of Pony, where slender hübnerite needles are found in quartz veins once worked for silver.

PRODUCTION.

The production of domestic tungsten ore in 1912 amounted to an equivalent of 1,330 tons of ore carrying 60 per cent tungsten trioxide (WO_3), of which 812 tons was ferberite from Boulder County, Colo.

The production of tungsten ore in the United States has been recorded only since 1900; before that time it was insignificant. As obtained by the United States Geological Survey the figures are as follows:

Production of concentrated tungsten ores in the United States, 1900–1912, in short tons.[a]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	46	$11,040	1907	1,640	$890,048
1901	179	27,720	1908	671	229,955
1902	184	34,040	1909	1,619	614,370
1903	292	43,639	1910	1,821	832,992
1904	740	184,000	1911	1,139	407,985
1905	803	268,676	1912	1,330	502,158
1906	928	348,867			

[a] The production of tungsten ores in this country from year to year can be fairly compared in this table only since and beginning with 1906, as before that date no effort was made to reduce the ores to a common basis of concentration. Since 1906 the ores have been, as far as possible, reduced to an equivalent of ore carrying 60 per cent tungsten trioxide (WO_3), which is the ordinary commercial basis in the United States.

WORLD'S PRODUCTION OF TUNGSTEN.

Figures showing the production in 1912 of the countries mining the largest quantities of tungsten ore are now available and show a considerable increase over 1911.

The world's production of tungsten ore, 1905–1912, by countries, estimated as far as possible, in short tons of concentrates containing 60 per cent of tungsten trioxide.

Country.	1905	1906	1907	1908	1909	1910	1911	1912
Africa: South Africa	.....	9	211	40	16	(a)	(a)	(a)
Asia:								
Burma and the Shan States	.....	.....	.....	.....	.....	407	[b] 1,119	[b] 2,095
Federated Malay States	.....	151	89	83	99	105	[c] 205	[c] 275
French Indo-China (Tonkin)	.....	.....	.....	.....	.....	19	.....	[d] 81
India (not including Burma)	.....	.....	.....	.....	7	[e] 23	.....	[f] (23)

[a] So far as can be learned, no tungsten ore was produced during the years indicated.

[b] M. K. Moorhead, United States consul, Rangoon, Burma, letter dated Apr. 3, 1913. As given by Mr. Moorhead, 995 short tons were exported in the calendar year 1911, and 1,861.98 tons, valued at $698,195, in 1912. He states that Messrs. Radcliff & Co., of Rangoon, estimate the percentage of WO_3 usually contained in wolframite exported from Burma to run from 65 to 70. The quantities have been reduced to a 60 per cent basis, the concentrates being supposed to average 67.5 per cent WO_3.

[c] Letter from Edwin S. Cunningham, United States consul general, Singapore, giving information obtained from W. E. Kenny, senior warden of mines, Federated Malay States. In 1911, 375,399 pounds of wolframite and 3,414 pounds of scheelite, and in 1912, 500,688 pounds of wolframite and 6,134 pounds of scheelite were produced, mostly from the tin placers in various parts of the States of Perak, Selangor, and Negri Sembilan, though the last State did not produce in 1912. The ore is separated magnetically and is said to carry 60 to 70 per cent WO_3. The ores have been reduced to a 60 per cent basis, on the supposed average of 65 per cent WO_3.

[d] Estimated. The Engineering and Mining Journal, vol. 94, Dec. 21, 1912 (p. 1181), prints a translation of an article from the Echo des Mines of Nov. 15, 1912, stating that the exports of wolframite from Tonkin for the first half of 1912 were 37 metric tons. This figure has been doubled for the year's output.

[e] Letter from H. H. Hayden, director geological survey of India, Aug. 16, 1911.

[f] Where no data are available the production of the last preceding year for which the figures are obtainable has been introduced to assist in forming an estimate of the production during 1912.

The world's production of tungsten ore, 1905–1912, by countries, estimated as far as possible, in short tons of concentrates containing 60 per cent of tungsten trioxide—Contd.

Country.	1905	1906	1907	1908	1909	1910	1911	1912
Asia—Continued.								
Japan	47	47	71	220	292	275	287	[a] 215
Siam	.....	.....	10	.....	.....	.....	[b] 200	[c] (200)
Australia:								
New South Wales	251	270	451	269	431	413	512	[d] 298
Northern Territory	71	230	177	40	49	[e] 78	[e] 71	[c] (71)
Queensland	1,582	865	703	516	679	1,145	750	[f] 944
Tasmania	36	22	46	5	20	75	86	[g] 87
Victoria	.....	.....	.....	3	15	31	[h] 33	[c] (33)
Western Australia	.....	.....	1	(*i*)	6	47	[j] 194	(*i*)
East Indies:								
Billiton	.....	.....	4	11	12	[k] 21	.....	[c] (21)
Singkep	.....	.....	1	14	12	12	.....	[l] 8
Europe:								
Austria	65	63	50	44	43	54	[m] 50	[c] (50)
England	193	304	361	261	421	307	298	[n] 216
France	28	20	67	124	55	33	(*i*)	(*i*)
German Empire (Saxony)	42	57	68	46	106	[o] 105	[o] 89	[c] (89)
Italy	36	28	18	.....	.....	(*i*)	(*i*)	(*i*)
Portugal	320	629	702	684	609	1,132	1,078	[p] 1,466
Spain	413	222	303	249	142	169	[q] 106	[c] (106)

[a] The data up to and including 1911 are from figures furnished by S. Katsuno in a letter dated July 6, 1912. Mr. Katsuno states that the output of scheelite and reinite (ferberite replacing scheelite) averages 35 long tons a year. The remainder of the output is wolframite dressed to 72 per cent WO_3. The figures for 1912, 359,144 pounds, are quoted in the Engineering and Mining Journal, vol. 96, 1913, p. 302, from "A report on the mineral industry of Japan, submitted by the British legation at Tokio." The ore is treated as 72 per cent WO_3 as in former years. The figures given by the Japanese Government, however, vary considerably from these. In "Mineral products, 1911, prepared by the statistical division of the department of agriculture and commerce" (Tokyo, 1913), the production is given thus: 1908, 310 kwan; 1909, 5,705 kwan; 1910, 28,217 kwan; 1911, 31,812 kwan. The kwan=8.267 pounds avoirdupois.

[b] Weeks, W. G., Notes on Mining in Siam, Royal Department Mines, Bangkok, 1912. The figures are for the Siamese year R. S. 130 (corresponding to the year from Apr. 1, 1911, to Mar. 31, 1912), and are given as 3,000 piculs (picul=133⅓ pounds) of wolframite, obtained from the dumps of old tin placers.

[c] Where no data are available the production of the last preceding year for which the figures are obtainable has been introduced to assist in forming an estimate of the production during 1912.

[d] Ann. Rept. Dept. Mines, New South Wales, for 1912, Sydney, 1913, pp. 60–61. As given, the figures were: Scheelite, 55.9 long tons; wolfram, 171.8 long tons. For purposes of conversion to a 60 per cent basis, the ores have been considered to carry 70 per cent WO_3, which is the content on which prices are based in Australia.

[e] Trade and customs and excise revenue of the Commonwealth of Australia for the year 1911, Melbourne (1912), p. 355. The figures given in this work represent the exports only from the port of final shipment, and are probably less than the actual output. The figures given are 1,086 (long) hundredweight wolfram. This is considered as carrying 70 per cent WO_3.

[f] Queensland Govt. Min. Jour., Brisbane, vol. 14, March, 1913, p. 125. The figures as given are: Wolfram, 626 long tons, 10 hundredweight; bismuth and wolfram, 191 long tons, 10 hundredweight. For convenience, the bismuth-wolframite mixture is treated as being half wolframite, as no figures are given to show the exact contents. The output is treated as carrying 70 per cent WO_3, the content of tungsten trioxide on which ores are understood to be bought in Australia.

[g] Wallace, W. H. The progress of the mineral industry of Tasmania. Quarters ending June 30 and Dec. 31, 1912. Hobart, 1912 and 1913. As given, the output was 66.49 long tons of wolframite. The percentage of WO_3 is unknown, but is supposed to be about 70, as in Australia.

[h] Annual report of the secretary for mines, Victoria, Melbourne, 1912, p. 28. The production was 17¼ long tons of wolframite concentrates and 15½ hundredweight of mixed wolframite and bismuth concentrates. The latter quantity has been considered as half wolframite, making 25 long tons, which is treated as 70 per cent WO_3.

[i] So far as can be learned, no tungsten ore was produced during the years indicated.

[j] Report Dept. Mines, Western Australia, 1911. Perth, 1912, p. 11. The exports were 9 long tons of wolframite.

[k] Letter from the Nederlandsche Handels-Maatschappij, dated Oct. 27, 1911.

[l] Report of Singkep Tin Co., quoted in the Mining Journal, London, vol. 100, Dec. 14, 1912, p. 1249. The report states that 169 bags of wolfram were produced in connection with the tin workings during the fiscal year 1911–12. The figure (about 8 long tons) given is an estimate based upon the supposition that the bags probably hold about 100 pounds each.

[m] Statistik des Bergbaues in Österreich, 1911. Wien, 1912, pt. 1, pp. 107–109. From old dumps at Teplitz and tin ores at Elbogen, 454.01 metric zentners of wolframite were obtained. Percentage of WO_3 in ore unknown.

[n] Mines and quarries: General report, with statistics for 1912, pt. 1, district statistics: Home office, London, 1913, p. 10. The quantity is given as 193 (long) tons. The percentage of WO_3 contained is not given. Wolframite.

[o] Mining Journal, London, vol. 100, Feb. 8, 1913, p. 131. Wolframite, 81 (metric?) tons. Percentage of WO_3 not given.

[p] Figures received from Snr. E. A. Ivo de Carvalho, Engro. das Minas, Lisbon, under date of Aug. 12, 1913. The figures as given are: Wolframite, 1911, 902.5 toneladas, and in 1912, 1,227.473 toneladas, carrying 65 per cent WO_3.

[q] Revista minera, metallúrgica y de ingeniería, Madrid, año 63, p. 225, 153 metric tons, and año 64, p. 123, 96 metric tons wolframite, content of WO_3 unknown. Given as 153.250 and 96 toneladas, respectively, Wolframite.

The world's production of tungsten ore, 1905–1912, by countries, estimated as far as possible, in short tons of concentrates containing 60 per cent of tungsten trioxide—Contd.

Country.	1905	1906	1907	1908	1909	1910	1911	1912
Oceania: New Zealand	64	121	153	87	78	187	[a] 184	[b] (184)
North America:								
Nova Scotia						83	(c)	[d] 17
United States	803	928	1,640	671	1,619	1,821	1,139	1,330
South America:								
Argentina		326	507	548	900	826	683	[e] 702
Bolivia	75	75	500	187	168	232	370	[f] 547
Brazil				16	(c)	(c)	(c)	(c)
Peru						15	[g] 57	[b] (57)
Total	4,026	4,367	6,133	4,113	5,779	7,615	7,511	9,115

[a] Papers and reports relating to minerals and mining: Mines Dept., New Zealand, Wellington, 1912, pp. 24, 54, 56, etc. The figures given are for the exports during the year 1911, 138 long tons of scheelite. Part of this, produced by the Glenorchy Scheelite Syndicate, is stated to have carried 72 per cent WO_3, and the whole output is reduced to a 60 per cent basis on the assumption that it was equally rich throughout.

[b] Where no data are available the production of the last preceding year for which the figures are obtainable has been introduced to assist in forming an estimate of the production during 1912.

[c] So far as can be learned, no tungsten ore was produced during the years indicated.

[d] Notes from the annual report of the department of mines of Nova Scotia. Year ended Sept. 30, 1912. Canadian Min. Jour., Toronto, vol. 34, p. 189. 14 tons scheelite, 72 per cent WO_3.

[e] El comercio exterior argentino, No. 156, año 1912. Dirección general de estadística de la Nación (Buenos Aires, 1913), p. 204. Figures as given are: "Wolframio, 637,170 k., val. $63,717" (Argentine dollar). The percentage of WO_3 is not known. Wolframite.

[f] Revista de Aduanas, quoted in the Mining Journal, London, vol. 101, Apr. 26, 1913, p. 405. The quantity of wolframite produced in 1912 is stated to have been 472,457 kilos, probably assaying about 63 per cent WO^3.

[g] Jiménez, C. P., Estadística minera del Perú en 1911. Cuerpo Ing. Minas, Lima, 1913, pp. 10, 46. The figures as given are: 1910, 13 metric tons, and, 1911, 48.5 metric tons, carrying 64 per cent WO_3.

Reports are available from nearly all the countries of large production and the reports from other countries will probably change the final figures very little.

The features of the table are the productions of Burma (including the Shan States) and Portugal. The Burmese production, equivalent to 2,095 short tons of 60 per cent WO_3, is the largest production ever made from any country. The total production of over 9,000 short tons of 60 per cent ore is much the largest world's production made to date.

PRICES.

During 1912 prices ranged from $5.60 to $7.50 per unit (the unit is 1 per cent of a short ton, or 20 pounds, of tungsten trioxide, WO_3) for ores carrying 60 per cent, or more, WO_3. Ores carrying less than 60 per cent sold at a much lower figure, owing to the costs and losses of milling and handling. At the end of the year $8 per unit was quoted, and there was a promise for better prices during 1913 than had prevailed in 1912. Although the prices paid in 1912 were somewhat higher than in 1911, when the range was from $4.50 to $8.50, with most of the sales near the lower figure, they were surprisingly low considering the great activity of the tool-steel trade, in which most tungsten is consumed.

However, the production of over 9,000 tons of concentrates and the existence of a considerable stock of tungsten concentrates in some hands at the beginning of the year sufficiently account for a comparatively low price during a large part of the year in spite of a very large tool-steel trade. In the world's production Burma, and in a less degree Portugal, were the countries of great increase and thus temporary disturbers of prices. The offerings of tungsten

ores were so large that prices could not rise until the tool-steel trade increased sufficiently to absorb the surplus concentrates on hand and catch up with the great increase in production. This growth in the manufacture and use of tool steel seems to have materialized in the latter half of the year and prices began to rise. The great improvement in tool steel through the introduction of cobalt (see "Cobalt") will probably add to the demand for tungsten on account of the greater efficiency of the steel and consequent economy in its use.

It seems probable that there is no reason to fear for the future price of tungsten from what can be foreseen. The alluvial tungsten of Burma and the Shan States will probably not produce so richly long, and as soon as the working of the lodes begins, upon the exhaustion of the placers, it is probable that production will decrease, at least temporarily. The price of tungsten will, as in the past, probably depend on the state of the steel trade.

USES.

Few new uses for tungsten are known to have been developed during the year, but the apparent absorption of more than 9,000 tons of concentrates carrying 60 per cent WO_3 shows a very great increase of consumption along known lines.

During the year Elwood Haynes placed on the market variations of his remarkable alloy of cobalt and chromium named stellite, in which a considerable percentage of tungsten is introduced. Some of these alloys have a hardness greater than tungsten steel, and on some classes of work stellite tools have given better service than the high-speed steels. This subject is treated at greater length under "Cobalt."

As stated above, the making of alloy steels for tools is still the greatest use for tungsten and probably takes more than 90 per cent of the metal.

The increase in the use of tungsten incandescent lamps has been notable, and they have now become common even on street cars, where the usage is especially severe. The use of metallic tungsten is in place of platinum for small electric furnaces operated in an atmosphere of hydrogen; for weights; for crucibles to be used in chemical work and in electric furnace work; for wire for use in surgical work; for targets in Röntgen tubes; for electrical contacts; and tungsten for bullets has been advocated and a small quantity is used in this way. Much experimenting has been done on alloys of tungsten with bronzes, brasses, aluminum, lead, and other alloys and metals, but so far as is known no alloys except the high-speed steels and stellite are regularly manufactured. It is claimed that 2 or 3 per cent of tungsten alloyed with aluminum gives an alloy very much harder than aluminum with only a little greater specific gravity. In some magnet steels 5 to 8 per cent of tungsten is used.

Tungsten salts are used as mordants and for weighting silks, for sealing platinum vessels in water determinations, as screens to make Röntgen rays visible, and in making bronzes. These uses are not large, and it is probable that the use of tungsten mordants is smaller than formerly. Most of the tungsten ore mined in this country was reduced to tungsten or to ferrotungsten, and tungsten ores, metallic tungsten, and ferrotungsten were also imported.

IMPORTS AND CONSUMPTION.

During 1912, according to the Division of Statistics, Bureau of Foreign and Domestic Commerce, there was imported into this country 323 short tons of tungsten and ferrotungsten, valued at $323,872. Unfortunately there is no way of telling from the returns how much of this is tungsten and how much is ferrotungsten, nor what percentage of tungsten is contained in the ferro.

There was also imported 824 short tons of tungsten ore, valued at $362,422. The countries in which the ores originated and the tungsten content of the ores are not given. It is safe to assume, however, that the ores are richer than 60 per cent WO_3.

It is known that there was a considerable stock of tungsten ore on hand in the United States at the beginning of the year, and that a large part, if not all of this, was absorbed during the year. These items being considered together make it seem probable that the consumption during 1912 was equivalent to nearly 3,000 short tons of ore carrying 60 per cent WO_3.

TUNGSTEN MINING IN BURMA.

Burma has become so important a factor in tungsten production, and so little is known of the deposits and mining conditions, that all tungsten producers must be interested in information concerning tungsten mining in that country.

The following excerpts are from an unsigned article, "Minerals in Burma," in the Rangoon Gazette of May 28, 1913 (pp. 21–23):

Wolfram, which continued to be worked on an extensive scale, gave employment to 1,528 persons, of whom 115 were women and 46 children, in the Tavoy and Mergui districts, the numbers employed in these two districts being, respectively, 629 and 899. In the previous year no less than 1,380 persons, including 35 women and 336 children, earned a livelihood by the industry in Tavoy, but then the attention of prospectors was solely directed to wolfram at the expense of tin mining; this year the popular attention was divided between the two industries, 90 men being engaged in tin mining. In Mergui the labor force shows an appreciable increase of 465 persons over the figures of the previous year, while in the Southern Shan States also there was an increase in the number employed in the tin and wolfram industries, being 133 men as compared with 106 in 1911.

The increases in the labor force employed in working wolfram in Mergui and lead slag and silver-lead ore in the Northern Shan States are due to the natural expansion of business in the extraction of these ores, while in Mergui wolfram was worked for the second year in the district. Both the Tavoy and the Mergui districts possess rich wolfram-bearing areas, but development is retarded owing to the absence of adequate communications; a light railway from the mining centers around Myitha and Pagiya, tapping Tavoy, and passing down to the river mouth, and likewise the provision of good roads, would tend toward the development not only of tin and wolfram in these districts, but of other industries as well, notably pottery manufacture and rubber cultivation.

The Southern Shan States appear also to be rich in tin and wolfram bearing areas, and though the cry from this quarter, as elsewhere in the Province, is the absence of adequate and rapid means of communications, the railway now in course of construction from Thazi to Taunggyi, when completed, should remove the present disabilities of transport by supplying a rapid and cheap means of communication between the States and the outside world.

Prospecting for wolfram commenced successfully on modern lines only a couple of years ago and already there has been very marked activity in Tavoy and in Mergui where the ore has been discovered in paying quantities. In the Southern Shan States also wolfram occurs and is being worked in conjunction with tin. The total production from the Tavoy and Mergui districts during the year under review (1912), though below that for the preceding year, was nevertheless considerable, amounting to 8,025

hundredweight, 2 quarters, 15 pounds, valued at 499,297 rupees [1] against 17,765 hundredweight of a value of 917,775 rupees. The principal decline was in the Tavoy district, the output having fallen from 15,060 hundredweight of the ore, valued at 753,000 rupees in 1911 to 2,467½ hundredweight of a value of 572,730 rupees in the year under reference. It is explained that owing to the fever being at its greatest height in 1911, the popular attention was entirely devoted to this ore, tin being neglected, but in the past year wiser counsels have prevailed and the attention of prospectors was once again devoted to both minerals. Wolfram occurs chiefly in the mountains to the east and northeast of Tavoy in fissure veins traversing the granite and associated argillaceous rocks metamorphosed by it. The tendency hitherto has been to a shortsighted policy in the methods of development employed generally in the district, attention seemingly being paid more to the immediate gain to be had from a large present outturn than to the ultimate benefit to be derived from a thorough knowledge of the extent and relationships of the ore bodies. This pursuance of the policy just described is largely responsible for the large outturn in 1911; but there now are indications that the industry is settling down to more normal conditions as a result of those engaged in it commencing to realize the fact that their financial interests will be best served by systematic development and that the methods previously employed which resulted merely in picking the eyes out of the country must only be injurious in the end. In Mergui wolfram was successfully worked for the first time in 1911 when 1,903 hundredweight of the ore, valued at 115,875 rupees were obtained; the production during the year under review shows a satisfactory increase of more than twice that of 1911, the output amounting to 4,356 hundredweight, valued at 254,447 rupees. In the Southern Shan States the output during the year amounted to 1,202 hundredweight; 7 pounds of wolfram and tinstone of a value of 72,120 rupees as compared with 802 hundredweight, valued at 48,900 rupees in 1911, and 660 hundredweight, worth 39,540 rupees, in the preceding year. The great success that has attended the venture in the Tavoy and Mergui districts and in the Southern Shan States augurs well for the future of the industries particularly, apart from the fact that the possibilities in this direction are admittedly great, as prospectors are now working the ore with greater economy and methods.

The rate per ton in the European market averages about 1,725 rupees. The cost of production, including all charges, scarcely ever exceeds 800 to 850 rupees, so that it will be obvious that the net profits amount to about 100 per cent on the outlay. Development at present is greatly handicapped owing to the lack of good communications and difficulties of transport, but it is to be hoped that with the construction of roads the drawbacks at present experienced will be reduced.

Further details are given in a letter from Crisp & Co., under date of July 21, 1913. They state that their property covers 6¼ square miles and that—

A range of low hills runs through the entire length of this concession for about 6 miles. The western slopes of these hills are rich with alluvial ore, consisting of pure stuff in small grains as well as lumps from the size of a marble up to the size of a man's fist. Some of these lumps are pure ore, but the bulk of it is mixed with stone and earth. In one instance we found a lump weighing 98 pounds of absolutely pure wolfram ore. This alluvial ore is found down to a depth of 3 to 6 feet, and we are devoting all our energies to work it out before operating on the veins in the hills.

We have made several adits and shafts in the hills to expose the veins with more or less success, but we are not exerting ourselves vigorously in this direction, as it would be unwise to do much excavation until all the alluvial ore is won.

The assay of our ore is 70 to 72 units WO_3, and our shipment in April last sold at Hamburg at 34 marks per unit.

These wolfram mines are located in the Tavoy and Mergui districts of Burma. Almost every likely ore-producing area has been taken up. Some are in the hands of big firms, but the bulk of these have been secured by natives, mostly speculators, who blindly applied for them on the chance of reselling at a profit. Many of these properties are, however, worthless and have been abandoned.

Besides ourselves, there are three European firms producing wolfram and a couple of native firms.

The ore is concentrated by hand, but one of these firms is introducing machinery.

We wash the earth in a stream of water, and collect the ore, which is broken up in pounders and then washed again. This is only possible during the rains, when water is plentiful, but for seven months in the year these operations cease from lack of water.

[1] The hundredweight is the English measure of 112 pounds. The value of the rupee is 30.823 cents.

Conditions farther north in the tungsten region are thus described in a letter from J. H. Means, dated July 18, 1913:

The Mawchi mines are situated at about 18° 50′ N., 97° 10′ E., in the native State of Karenni, about 16 miles by trail west of the Salween River, in a rough mountainous district, well timbered and well watered, at an altitude of approximately 3,000 feet above sea, but this varies within the property, however, between 1,600 and 5,100 feet above sea.

The country rocks are principally granite, marble, quartzite, and arenaceous shales.

There is a granite mass nearly 1 square mile in area. On one side it is in contact with heavily bedded marble, which dips away from the granite at a steep angle, and in places extends over the top of it as a cap. The remainder of the granite boundary is in contact with quartzite.

* * * * * * *

The granite is of light color, and although it varies somewhat locally, in general it has a very acid appearance, containing relatively small quantities of basic minerals, mostly hornblende.

There is little muscovite or biotite. Tourmaline, however, is very common locally. No pegmatite or other dikes have yet been observed, but they may possibly occur and be unobserved where the surface is overgrown by the tropical vegetation.

A series of approximately parallel and nearly vertical quartz veins, 3½ to 5 feet wide, are found in both the granite mass and the adjacent siliceous rocks.

Development work, so far, has been concentrated on seven of these veins, all of which are in the granite mass.

* * * * * * *

Cassiterite and wolframite (or possibly ferberite) are associated with iron pyrite, a small quantity of scheelite, arsenopyrite, and some tourmaline in a hard quartz gangue.

The cassiterite and the wolframite occur irregularly in flat lenticular masses near the walls, and in rich nests or patches and in less important disseminated bits.

There are also tin and wolfram bearing alluvials from surface disintegration of vein outcrops and contact zones, which are worked to a limited extent by natives.

This property is now only in the development and equipment stage. A mill is being erected for treating the ore by crushing and concentration. The concentrates are to be calcined and separated by magnetic separator.

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Returns to hand from one shipment show that when separated about equal amounts each of tin and wolfram concentrates were obtained.

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A good mill run of the ore may, however, show a very different result.

Wolframite deposits near Tavoy are described by A. W. G. Bleeck[1] as follows:

* * * * * * *

The Tavoy district in the Tenasserim division of Lower Burma is bounded to the south by the Mergui district, the southernmost district in Burma, on the east by Siam, on the west by the Bay of Bengal, and on the north by the Amherst district. There are three main rivers in the district which are navigable for considerable distances by country boats and even by launches, i. e., the Tavoy River and the Great and Lesser Tenasserim rivers. The Tavoy River flows into the sea at a distance of about 30 miles below the town of Tavoy. The great Tenasserim River flows south into the Mergui district, and the Lesser Tenasserim is one of its tributaries.

The town of Tavoy is the headquarters of the Tavoy district. The only other town of importance is Myitha, on the Lesser Tenasserim River or, as it is locally termed, the Ban River. Villages are few and far between and generally consist of half a dozen houses (more or less). Provisions are scarce and very difficult to obtain in these hamlets. The population consists chiefly of Burmese, with a few Chinese and natives of India.

With the exception of the flat land bordering the larger rivers and streams the country is very mountainous. The general strike of the ranges is north-northwest–south-southeast. Elevations up to 6,000 feet are recorded. For the most part the country is thickly jungle clad, with high forest and impenetrable undergrowth. Hill streams and torrents are innumerable and most of them carry perennial water. Narrow and deeply eroded valleys therefore form a main feature of the country.

[1] On some occurrences of wolframite lodes and deposits in the Tavoy district of Lower Burma: Records, Geol. Survey of India, vol. 43, pt. 1, 1913, pp. 48–74, 2 plates.

The climate is by no means all that could be desired. The jungles are infested by mosquitoes, sandflies, etc., and every precaution must be taken to guard against fever. The rainfall is a very heavy one, close upon 300 inches per annum, and most of this falls between the middle of April and the end of October.

Two distinct types of rock are found, i. e., stratified rocks consisting mainly of quartzites and schists, and intrusive rocks of acid types.

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For the purpose of their mineralogical and petrological discussion no distinction can be drawn between ore-bearing lodes and barren quartz veins, since I regard the ores simply as local accessories of the quartz veins.

* * * * * * *

Quartz veins are very numerous throughout the country examined. They vary in width from a fraction of an inch to 12 feet and more in thickness. The thickness of each individual vein varies again along the strike and to the dip.

A large number of quartz veins was observed in the granite along the twenty-first mile on the Tavoy wagon road. Here they are more frequent near the outer margin of the granite and near the contact with the metamorphic rocks. The veins stand almost vertical and appear to dip in toward the center of the granite boss.

* * * * * * *

The lodes were evidently formed in irregular contraction fissures near the outer margin of the granite. Individual veins, each one continuously varying in thickness, have been traced for considerable distances (a quarter of a mile or more) in the granite, but only along the strike. Nothing as yet is known of the conditions to the dip.

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As the quartz veins stand the weathering very much better than the country-rock, they generally stand out prominently and can easily be traced over the hillsides.

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According to their mineral contents the lodes of the Tavoy district, so far as I was able to visit them, can be divided into three subdivisions having regard to the ore contents of the lodes:

1st, the wolframite-quartz lodes;

2d, the cassiterite-quartz lodes; and

3d, the wolframite greisen.

The wolframite-quartz lodes are the most important of this group. Of the other two lodes only one of each was observed. They will be treated separately at the end of this section.

The wolframite occurs in scattered and irregular patches in a white opaque mass of quartz. Single crystals of wolframite up to 3 and 4 inches in length, as well as large masses of crystal aggregates weighing up to 90 pounds, are sometimes found, forming the visible ore of the lodes. On those lodes, which have been proved to be ore-bearing, long stretches apparently carry no wolfram values whatsoever. Then again the quartz is studded with single wolframite crystals, or aggregates of such crystals, for considerable distances. It is thus impossible to estimate, even approximately, the ore contents of any of these lodes. In order to arrive at the percentage of wolframite in the lode, bulk sampling on a large scale would have to be carried out. I have already mentioned that a large number of barren quartz veins were observed. The quartz of these veins is very similar in appearance to that of the wolframite-quartz veins. Considering the erratic occurrence of the wolframite in the lodes, I am of opinion that these barren quartz veins are in some part or another ore bearing, and that in all probability one and the same lode may carry wolframite values for a short distance and then run into a perfectly barren quartz lode which may continue barren for considerable distances.

At the present stage of exploitation nothing can be said with regard to the relationship of ore contents of the lode to the country rock. The lodes are alike in appearance, both in the granite and in the metamorphic rocks.

Equally there are no data available as to whether the lodes increase or decrease in richness at depth. Wolframite lodes, needless to say, can never show any secondary enrichment.

A distinct relationship exists between the richness of lodes and the strike of the lodes. Lodes running against the general strike direction of the metamorphic rocks are apparently richer than lodes following the strike direction, and this more especially wherever the lode changes its direction of strike. Observations of this kind were made at Kadwe.

* * * * * * *

Wolframite and tungsten ocher are the only wolfram ores of any economic value found in the lodes.

A typical variety of the wolframite contains about 76 per cent of tungsten trioxide. The color of the mineral is dark, iron or reddish-black. * * * Tungstite (yellow ocher of tungsten) is found in very small quantities together with wolframite and very often forms a thin yellow coating over that mineral. Tungstite is undoubtedly a product of decomposition of the wolframite.

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Mica.—Four distinct members of the mica division occur in the lodes. The size of a single flake of any of them is small, generally under one-eighth of an inch in diameter. * * * The commonest variety is muscovite, of which small colorless or yellow flakes occur throughout the lodes. In some lodes lithia-chlorite was observed. This is yellowish brown; the lithia can only be detected chemically. A third member of the mica division, which occurs very frequently in all lodes, is the ordinary green chlorite. Microscopically this chlorite was determined as pennine.

The following minerals have been observed in all the lodes, but in negligible quantities: Molybdenite, bismuthite, iron pyrites, copper pyrites, galena, and mispickle. Columbite, in black orthorhombic crystals, was observed in all the lodes. Tourmaline is present everywhere, generally in microscopic crystals.

Cassiterite is very rare in the wolframite-quartz lodes in all the localities examined by myself. But at Hermyingyi and several other localities it is said to be an important ore in the lodes.

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A lode observed at Kalonta was composed of quartz-muscovite and wolframite. It was observed in situ close to the quartz-tin and quartz-wolframite lodes. In this lode the quartz is of the usual granite type; that is to say, it forms with the mica a rock having the appearance of an intrusive dike and may be classed as a greisen. The micas show a lithia reaction. Wolframite occurs in small crystals scattered throughout this rock. Tourmaline is an accessory of this greisen.

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Float deposits.—Of considerable importance from an economic point of view are the workable float deposits which are found in close proximity to the lodes. The disintegration of the wolframite lodes have led to the formation of ore concentrates constituting workable deposits.

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The wolframite breaks up very easily and is generally found in small prisms varying in size from dust up to half an inch in length. In close proximity to the lodes the float ore generally consists of wolframite or cassiterite still surrounded by gangue quartz.

* * * * * * *

Generally speaking there are three different kinds of float deposits. The first is the float deposit within the granite country. In the granite hills the valleys are generally much steeper and narrower than in the metamorphic areas. The float deposits, therefore, generally consist of large granite bowlders, together with the lode-float. The thickness of the float deposits is very inconsiderable and the float ore is often carried a considerable distance away from the lode. The second kind of float deposit is characterized by large and small bowlders of hard quartzites, in which the pure wolframite or quartz-wolframite bowlders are embedded. In this kind of deposit the wash is loose and the ore easily won. A third kind of float deposit generally occurs in the softer metamorphic rocks. On disintegration these latter form a sticky clay in which the wolframite float becomes embedded. The ore from these float deposits is not so easily won, since the clay requires a great deal of puddling.

The alluvial deposits vary in thickness from a few inches on hillsides to several feet in the valleys.

In a later publication[1] Dr. Bleeck states that no figures showing the percentage of tungsten in the lodes can yet be given, owing to the lack of development. One vein sampled gave less than one-fourth of 1 per cent (WO_3?). From another vein, wolframite was profitably chipped from the outcrop. Most of the wolframite comes from alluvial deposits worked by natives on contract, who earn about 48

[1] Bleeck, A. W. G., Economic development of the wolframite deposits in the Tavoy district of Lower Burma (no date nor place of publication given), 6 pp.

cents a day. The cost of production for a concession 20 miles from Tavoy is given as follows:

Cost of production of tungsten in the Tavoy district, Burma.

	R.	A.	
Average contract price per ton for collecting 68 per cent ore	400	0	$129.77
Average transport price to Tavoy	15	8	5.03
Transport to wharf	2	0	.65
Ore bags and bagging	15	0	4.87
Royalty to Government	34	0	11.04
Customs freight to Rangoon	7	7	2.41
Tools and stores	13	8	4.38
Traveling expenses of staff	30	8	9.90
General Tavoy expenses	49	4	15.98
Indian supervision	30	0	9.74
European supervision	320	0	103.80
Freight to England, storage, and assay charges	50	0	16.22
Total	967	3	313.79
The revenue per ton of 68 per cent concentrate at 30s. per ton (*sic.* Evidently unit is meant)	1,530	0	496.00
Thus leaving a net profit of about	562	13	182.00

It will be seen from the foregoing descriptions that there is a long north-south strip, rich in wolframite accompanied by considerable cassiterite (tin oxide), which, beginning with the Southern Shan States in 21° or 22° north latitude, follows the trend of the mountains and stretches through Tavoy (14° north latitude) and Mergui (11° or 12° north latitude).

The mountains are the backbone of the Malay Peninsula, and were formed by the intrusion of granite probably of, or younger than, late Carboniferous or Permian age, as it intrudes Gondwana sediments supposed to be of that age.[1] The greatest tin deposits of the world are found along the west side of the range in Perak, Selangor, and Negri Sembilan (2° to 6° north latitude). More or less wolframite occurs with the cassiterite in the great alluvial deposits formed through the wearing down and decay of the rocks containing the minerals. Farther north in Mergui, Tavoy, and the Southern Shan States the proportion of wolframite to cassiterite is much larger, and in some veins the cassiterite is apparently wanting. On the east wolframite is found with cassiterite in the closely related and more or less parallel ranges of Siam, and in smaller quantity in Tonkin.

The tungsten-bearing areas are very large and apparently closely related geologically, and it would not be surprising to see developed in Burma much the largest tungsten-bearing territory of the world, not only from the easily worked placers, but afterwards from the veins. As has been noted, the production for 1912 was the largest ever made by any country, and it was practically all from placers.

[1] See Scrivenor, J. B., The geology and mining industry of the Kinta district, Perak, Federated Malay States: Kuala Lumpur, 1913, pp. 42–43, et seq.

URANIUM AND VANADIUM.

By Frank L. Hess.

PRODUCTION AND OCCURRENCE.

The figures for the production of vanadium and uranium ores were not very satisfactorily reported for 1912, and the output has therefore been partly estimated from various data in the possession of the Survey. In the United States uranium and vanadium bearing minerals were produced only from the soft sandstones of the high plateau regions of southwestern Colorado and southeastern Utah, except a very small quantity of pitchblende and uraninite. Much the larger part of the ores were from Colorado.

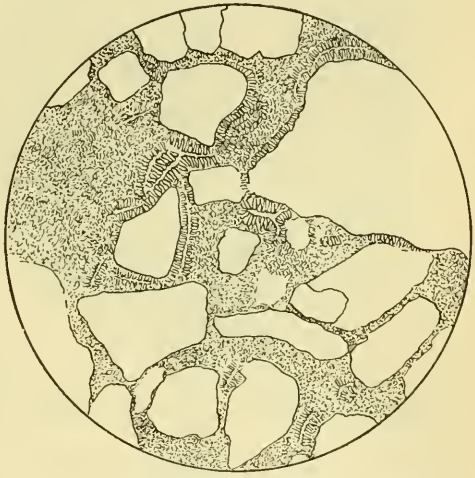


Figure 10.—Section of sandstone having wide pore spaces filled with roscoelite, partly radial. White space, quartz; shaded area, roscoelite. Enlarged about 225 diameters.

The production of uranium appears to have been equivalent to a little less than 26 short tons of uranium oxide (U_3O_8), or approximately 22 tons of metallic uranium, a slight increase over 1911, when the production was equal to about 25 tons of uranium oxide, or 21.2 tons of the metal. The production and sale of pitchblende and uraninite in Colorado and North Carolina amounted to only 275 pounds, which brought $1,498. The vanadium output of 1912 seems to have been equivalent to a little less than 300 tons of metallic vanadium, a somewhat larger quantity than that of 1911.

The reduction of the figures to terms of metal seems to be the most feasible way of representing the output of both uranium and vanadium ores, as the ores are of many percentages and there is no generally accepted standard of grade, as there is in tungsten ore, for which, in the United States, the standard is an ore containing 60 per cent tungsten trioxide (WO_3).

The greatest part of the vanadium produced is, as stated, from sandstone carrying roscoelite between the grains; the next largest is from sandstone with similarly interstitial carnotite; and less quantities are obtained from other vanadium minerals not yet thoroughly investigated. The roscoelite occurs mostly as minute flakes between the fine grains of sand of the flat-lying La Plata sandstone, but most of it shows no characteristic forms. (See fig. 10.) In the

roscoelite deposits is generally an inconspicuous dark-green layer, one-half inch to three-fourths inch thick which looks like shale but is really a unique vein composed of roscoelite with a little quartz. (See fig. 11.) The veins lie along partings in the sandstone which have apparently acted as channels along which vanadiferous solutions have traveled and have impregnated the sandstone, either above or below or both, to an extreme thickness of more than 30 feet. The vanadiferous sandstone is generally a sage green, and its richness is more or less indicated by the depth of the color. Some of the richest rock is practically black. It seems probable, however, that the black rock obtains its color from some other source than roscoelite, and it is probably from the same dark vanadiferous substance that gives color to some of the ores from Paradox Valley, to which reference will be made in another paragraph.

FIGURE 11.—Section of roscoelite vein. Shaded area, roscoelite; white area, quartz, except at the top, which shows the edge of the section; black area, pyrite. Enlarged about 225 diameters.

The roscoelite sandstone lies nearer the mountains than the other ores, and, as it happens, much nearer a railroad. (See fig. 12.) Most of the ore is too lean to bear transportation, carrying less than 3 per cent of metallic vanadium, and must be concentrated before shipping. So far concentration has been accomplished successfully only by chemical means and this is being done by the Primos Chemical Co. at Newmire. The process consists of a salt roast, lixiviation, and precipitation with an iron salt, the vanadium coming down as an iron vanadate which is filter-pressed and shipped east for reduction to ferrovanadium.

The company's mines lie 2 miles south of Newmire, up Big Bear Creek. Newspapers report that a 6-ton automobile truck is now used in hauling between mines and mill.

The many other claims carrying roscoelite in the vicinity of Newmire, Sawpit, and Placerville are not known to have been productive during the year.

The carnotite ores are found in Paradox Valley, Long Park, the McIntyre district and adjacent territory in Montrose County, and extend into Dolores, San Miguel, and Mesa counties. In Utah the deposits mined lie in Grand and Emery counties. Deposits which were unproductive during the year are found in Routt, Moffat, and Rio Blanco counties, Colo., and in Uinta and Wasatch counties, Utah.

Carnotite is a canary-yellow mineral, somewhat variable in composition, containing vanadium and uranium with either or both lime and potash. It is ordinarily a mixture of true carnotite, the potash

mineral ($2UO_3.V_2O_5.\ K_2O+xH_2O$), and tjuyamunite, the lime mineral ($2UO_3.V_2O_5.\ CaO+xH_2O$).[1]

It is ordinarily a powdery or waxy-looking mineral in minute scales filling interstices and small cracks in the sandstones and included fossil bones and petrified wood. With a hand lens it can in places be seen to have a somewhat radial but rather indefinite crystal form. Very rarely it takes a solid form, which cuts like paraffine and has an unctuous feel. In the powdery form the color may be somewhat disguised by iron oxide or calcium vanadate.

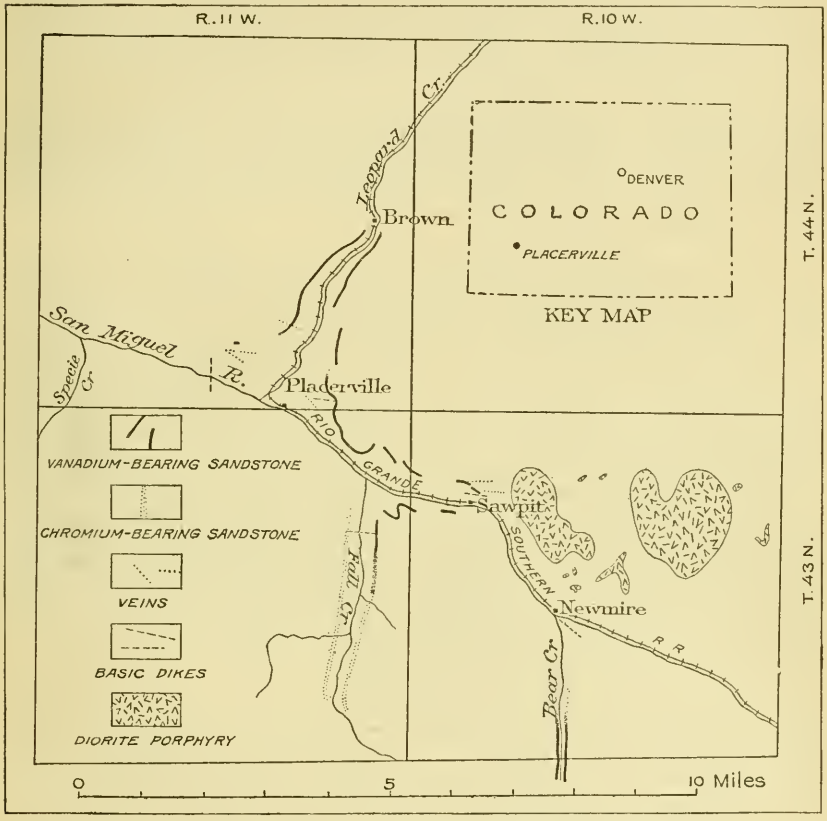


FIGURE 12.—Sketch map of the vanadium deposits near Placerville, Colo.

Carnotite rarely occurs in the rocks without other uranium and vanadium minerals, so that the relative percentages of the uranium and vanadium contained in carnotite ores vary considerably. In the ores shipped during 1912 the percentage of uranium oxide (U_3O_8) varied from 0.5 to 6.32, and the percentage of vanadium oxide (V_2O_5) in the same ores varied from 1.42 to 13.63. The ratio between the uranium oxide and the vanadium oxide was likewise variable. At one extreme was an ore that carried 8.15 per cent vanadium oxide (V_2O_5) and 1.54 per cent uranium oxide (U_3O_8); at the other extreme

[1] Unpublished work of W. F. Hillebrand. Tjuyamunite has recently been described and named by K. A. Nenadkevich. Bull. Acad. Imp. Sci., St. Petersburg, 6 ser. Nov., 1, 1912, pp. 945–946.

was an ore that carried 5.79 per cent vanadium oxide and 6.32 per cent uranium oxide. In normal carnotite the ratio of vanadium oxide (V_2O_5) to uranium oxide (U_3O_8) is almost as 1 to 3. It will be at once seen that all the ores shipped contain a larger percentage of V_2O_5 compared with the U_3O_8 than pure carnotite would carry, and all must therefore carry other vanadium minerals.

In the Paradox Valley, especially, sandstone is found the grains of which are coated with a black vanadiferous substance which on exposure to air and light turns bluish, greenish, or yellowish. The mineral or mixture of minerals is, like carnotite, from the oxidized zone, but its character is little known and it is probably a mixture of substances. Hillebrand, Wright, and Merwin in a preliminary study of material from the Joe Dandy claim, Paradox Valley, say: [1]

> It is not carbonaceous as one might suspect, but the black color is due to a vanadium mineral occurring in distinct prisms (whether this is a calcium compound or not is as yet undetermined). It is somewhat doubtful if chemical study will reveal its exact composition, for other vanadium compounds are present with the black ore, as is indicated by the existence of vanadium in three states of oxidation, corresponding to V_2O_5, V_2O_4, and V_2O_3. The greater part of the vanadium is in the V_2O_4 state, and to this the color of the rock seems to be due.

So far as is known, this mineral has been found only as a cementing or interstitial material in the sandstone, and never fills cavities sufficiently large to be discernible to the unaided eye.

In much smaller quantity are red calcium vanadates now under investigation by Hillebrand and Merwin, which appear to be of two varieties with a rather similar general appearance, but differing considerably optically. These vanadates are fibrous and occur in cracks and small and large cavities. About five tons of the comparatively pure mineral was removed from a deposit on the property of the Vanadium Ores Mining & Milling Co. south of Thompsons, Utah. The calcium vanadate is said to have occurred in seams 5 to 6 inches thick with vanadiferous sandstone 2 to 3 inches thick between. The calcium vanadate from this deposit is a deep dark red which when exposed to the atmosphere changes to a bronzy color.

The specimens received from the Paradox Valley are in part of a lighter red color and are better crystallized.

A small quantity of a similar material has been found on the Browning & Beebe claims at Castle Rock (Wild Horse Canyon) in the southeastern part of the San Rafael Swell, Emery County, Utah.

Two varieties of a mineral closely related to calciovolborthite have been described by Hillebrand and Merwin [2] from Richardson, Grand County, Utah, but they differ from typical calciovolborthite (hydrous calcium copper vanadate) in containing arsenic—one contained 17.2 per cent. The analyses are given elsewhere in this article. Similar minerals have been found in Paradox Valley. They are greenish yellow and yellowish green, in platy crystals, some arranged in rosettes. It is probable that volborthite, a hydrous vanadate of copper, barium, and calcium, also occurs in the deposits.

In those deposits which have not yet been developed to commercial production are a number of minerals little investigated. Black

[1] Hillebrand, W. F., Wright, F. E., and Merwin, H. E., Calcium vanadates from Peru, Colorado, and Utah: Jour. Washington Acad. Sci., vol. 3, Mar. 19, 1913, p. 158.

[2] Hillebrand, W. F. and Merwin, H. E., Two varieties of calciovolborthite (?) from eastern Utah: Am. Jour. Sci., 4th ser., vol. 35, 1913, pp. 441–445.

carbonaceous shales from Pass Creek, 9 miles south of Malachite, Huerfano County, Colo., contain golden-yellow and yellowish-green minerals which appear to belong to the volborthite and calciovolborthite groups. Similar deposits have been reported as occurring a few miles southeast of Silver Cliff, Custer County, and Fleck [1] describes the occurrence of a mineral which he determined as volborthite at Garos (Garo?), Park County, in Jura-Trias sandstones, cut by an old, partly filled trench.

In Boren Gulch, La Plata County, in a quartz vein discovered by C. C. Carnell, is an unidentified vanadium mineral in yellowish-green globular masses 1 millimeter or less across, accompanied by golden-yellow scales, which are possibly volborthite, and by malachite.

Nine miles south of Paria, Utah, autunite, a hydrous phosphate of uranium and calcium, and uranospinite, probably a hydrous arsenate of uranium and calcium, occur in small scales in the crevices of a sandstone, presumably of Jura-Trias age, but little is known of the deposit, as to age, richness, or extent. So far as is known this is the only deposit of the plateau region in which uranium seems to be in excess of vanadium.

OPERATIONS AND SHIPMENTS.

As has already been mentioned, the output of roscoelite-bearing sandstones was confined to the Primos Chemical Co.'s mine and reduction plant at Newmire, which company was the largest vanadium operator in the field.

In Paradox Valley, Long Park, and adjacent territory the principal miners and shippers during the year were the Colorado Carnotite Co., Curran & Hudson, General Vanadium Co., C. H. McKeever, Standard Chemical Co., and Arden M. Wilson. The ores shipped by operators were all carnotite, with the accompanying vanadium minerals.

The General Vanadium Co. is a subsidiary of an English company said to be controlled by George Blackwell Sons & Co., of Liverpool, England, and its ore is shipped to Liverpool. About 1,100 tons of uranium-vanadium ore was shipped from Paradox Valley and adjacent territory during the year, and of this, far the largest part went to Europe, though a part was shipped to Pittsburgh and a part to New York.

Much has been made of the fact that most of the ore with its contained radium went to Europe for separation, but it is doubtful whether the profits made on the radium by the firms separating the minerals have been at all fabulous. The separation of vanadium and uranium depends on nice chemical manipulation. To be successful, the separation must produce uranium salts containing no vanadium, and vanadium salts free from uranium. One company is known to give the uranium and radium in its ore to another company if the latter will return the vanadium of the ore in a salt free from uranium. The market for uranium salts is limited at best and is apparently easily supplied so long as prices remain at a level which justifies their preparation under present conditions. During 1912 the uranium salt produced by one company is known to have gone begging for a market, owing possibly in part at least to its containing vanadium, the separation having been imperfect.

[1] Fleck, Herman, The vanadium deposits at Garos, Park County, Colo.: Quart. Colorado School of Mines, January, 1909, pp. 35–36.

EXTRACTION OF RADIUM FROM CARNOTITE.

Of course carnotite ores, as do all uranium ores, carry minute quantities of radium, and it has been thought by many that the radium must be a great source of profit for which the miner was getting nothing. Many experiments have been made in the United States with the object of separating radium from carnotite, but most experimenters have found that the cost of extraction of the minute quantities contained in the ore, including the cost of mining, transportation, chemical and technical knowledge was so great that even with the enormous prices quoted for radium the process did not pay. Two companies, however, the Standard Chemical Co., of Pittsburgh, Pa., and the Radium Co. of America, of Sellersville, Pa., have so far solved the difficulties as to establish plants for the production of radium. The former company is the older, and at the close of 1912 was ready to begin the production of radium. The Radium Co. of America was still experimenting at the close of the year.

THE QUANTITY OF RADIUM IN CARNOTITE.

Mlle. Ellen Gleditsch [a] found that carnotite carries from 0.00000375 to 0.00000380 gram of radium per 100 grams of mineral carrying 16 per cent uranium, or $\frac{Ra}{U}=2.34\times10^{-7}$. That is, the radium in carnotite is equal to 0.000000234 part of the uranium present in the ore. A ton of uranium would therefore carry 213 milligrams (3.28 grains) of radium, or 396 milligrams (6.1 grains) of radium bromide ($RaBr_2 2H_2O$), the form in which it is usually sold. If these figures of Mlle. Gleditsch are correct for Colorado carnotite in general, the 22 tons of uranium in the ores sold during 1912 was accompanied by approximately 4.69 grams (72.2 grains) of radium.

Very little of the ore shipped carries more than 3 per cent uranium oxide (U_3O_8) or 2.54 per cent uranium, and the average content of the ores shipped was about 2 per cent uranium (metallic). In such an ore the radium bromide ($RaBr_2 2H_2O$) content would be, on Mlle. Gleditsch's basis, equivalent to about 7.9 milligrams or a little more than 0.122 grain per ton.

The radioactivity of carnotite, as tested by Mlle. Gleditsch, compared with radioactive minerals from other parts of the world is given by her as follows: [b]

Comparative radioactivity of uranium and thorium minerals as determined by Mlle. Ellen Gleditsch.

Mineral.	Locality.	Activity.	Radium per 100 parts.	Uranium per 100 parts.	Ratio $\frac{Ra}{U}$
Torbernite [c]	Saxony		0.714×10^{-5}	39.29	1.82×10^{-7}
Carnotite	Colorado	0.76	0.375×10	16.00	2.34×10
Gummite; partly soluble	Germany		0.31×10	12.20	2.54×10
Autunite	Autun, France	1.52	1.20×10	46.92	2.56×10
Do	Tonkin	1.50	1.22×10	47.10	2.59×10
Torbernite	Germany	1.20	0.905×10	28.80	3.14×10
Pitchblende	Joachimsthal, Austria	1.90	1.48×10	46.10	3.21×10
Gummite; mineral brut (1)	Germany	1.23	0.58×10	17.37	3.34×10

[a] Sur le rapport entre l'uranium et le radium dans les minéraux actifs: Le Radium, Paris, vol. 8, 1911, p. 260.

[b] Idem, p. 269.

[c] In the original "chalcolite," an old term, which "has crept back" into use (see Dana's System of Mineralogy, p. 857), is used for torbernite, the hydrous phosphate of uranium and copper, $Ca(UO_2)P_2O_8+8H_2O$.

Comparative radioactivity of uranium and thorium minerals as determined by Mlle. Ellen Gleditsch—Continued.

Mineral.	Locality.	Activity.	Radium per 100 parts.	Uranium per 100 parts.	Ratio $\frac{Ra}{U}$
Torbernite	Portugal	1.70	1.30 ×10	39.03	3.33×10
Do	do	1.70	1.21 ×10	36.20	3.33×10
Do	do	0.04	0.024×10	0.724	3.35×10
Samarskite	India	0.42	0.295×10	8.80	3.35×10
Broeggerite	Norway	3.90	2.10 ×10	63.89	3.29×10
Cléveite	do	2.96	1.81 ×10	54.90	3.32×10
Uranothorite	do	0.76	0.16 ×10	4.83	3.31×10
Pitchblende (2)	do	3.12	2.05 ×10	58.90	3.48×10
Fergusonite	do	0.30	0.223×10	6.30	3.55×10
Pitchblende (1)	do	0.29	0.17 ×10	4.67	3.64×10
Thorianite	Ceylon	2.32	0.66 ×10	18.60	3.55×10
Torbernite	Cornwall	2.00	1.70 ×10	48.66	3.49×10
Pitchblende	do	1.40	1.07 ×10	28.70	3.74×10

Strutt[a] in February, 1905, published a ratio of radium to uranium in carnotite of 1.76, equal to 5.27 millionths of 1 per cent of radium bromide. He gave a table of comparative results, as follows:

Comparative radioactivity of uranium and thorium minerals as determined by R. J. Strutt.

Mineral.	Locality where found.	Radium bromide, millionths of 1 per cent.	Uranium oxide (U_3O_8), per cent.	Thorium oxide (Th. O_2), per cent.	Helium, cubic centimeters per gram of mineral.	Total activity, uranium oxide (U_3O_8), taken as unit.	Ratio of radium to uranium.
Pitchblende	Joachimsthal	153.0	73.5	0	0.107	3.11	2.10
Torbernite[b]	Cornwall	120.0	[b] 60.0	0	0.10	2.00	2.00
Pitchblende	do	60.6	29.15	0	0.08	0.867	2.00
Do	Near Grampound Road Station, Cornwall.	48.5	21.23	0	0.10	1.17	2.28
Thorianite[c]	Ceylon	30.4	13.0	77	8.9	2.48	2.34
Æschynte	Hitteroe, Norway	24.0	9.42	1.26	1.09	0.606	2.54
Samarskite	North Carolina	22.5	10.30	1.46	1.5	0.495	2.18
Gadolinite (?)[d]	Ytterby	11.7	2.94	8.60	2.43	0.380	3.98
Æschynite	Ural Mountains	9.90	2.50	8.18	0.98	0.249	3.99
Cyrtolite	Llano County, Tex.	8.98	3.67	5.05	1.15	0.468	2.45
Sipylite	Little Friar Mountain, Va.	8.82	2.86	[e] 4.92	0.59	0.514	3.08
Euxenite	Arendal, Norway	5.56	2.84	2.72	0.73	0.245	1.96
Carnotite[f]	Montrose County, Colo.	5.27	2.98	0	0.01	0.474	1.76
Pyromorphite[g]	Issy L'Eveque, France	4.39	0	0	0.02	0.0655	.....
Microlite	Amelia Courthouse, Va.	3.70	1.89	0	0.05	0.101	1.96
Orangite	Brevig, Norway	2.82	[h] 1.0	48.5	0.11	1.07	2.82
Monazite I	Norway	2.35	[h] 1.0	0.650	1.54	0.316	2.35
Monazite	Amelia Courthouse, Va.	0.806	[h] 0.1	2.43	1.57	0.101	0.8
Kolm[i]	Sweden	0.670	0.377	0	.....	0.0174	1.78

[a] Strutt, R. J., The radio-active minerals: Proc. Roy. Soc. London, vol. 76, 1905, p. 95.

[b] This number was assumed from various published analyses of the mineral, which are very concordant. The crystals are transparent, and it was possible to pick them out from the matrix in such a manner as to insure purity. Strutt uses the name "cupro-uranite" for torbernite.

[c] See Nature, vol. 69, p. 510.

[d] I am satisfied that this mineral is correctly named, for the amounts of uranium, thorium, and helium contained are all much larger than published analyses would indicate. Fortunately the name is of little importance for the present purpose.

[e] The presence of thorium in this mineral seems to have escaped previous observers.

[f] This mineral is finely disseminated throughout a sandstone matrix; it was not thought necessary to separate it, but a quantity was uniformly powdered with the matrix. This explains the low uranium percentage given, as compared with that of the pure mineral.

[g] This is the mineral recently described by M. J. Danne (Compt. Rend., Jan. 23, 1905), and I am indebted to his kindness for the sample.

[h] These determinations of uranium are rough ones only, very kindly made for me by my friend Mr. H. J. H. Fenton, F. R. S., on a small quantity of material.

[i] This is a bituminous material, occurring in alum slate, in Sweden. Its radioactivity was detected by Mr. John Landin, of Stockholm, and he most kindly sent the sample. The material is said to be very abundant where it occurs. About two-thirds of it can be burnt away, leaving one-third by weight of ash. This ash contains the radioactive constituents. In making the determinations, a sample of the mineral was burnt, the ash being weighed. The percentages of radium and uranium in this ash were determined, and afterwards referred back to the weight of the unburnt mineral. (See within under Swedish uranium deposits.—F. L. H.)

Boltwood,[1] in April of the same year (1905), also published tables giving the comparative ratio of radium to uranium, in which he finds a ratio of 220. His table is as follows:

Comparative radioactivity of uranium and thorium minerals as determined by B. B. Boltwood.

Substance.	Locality.	1	2	3	4	5. Percentage of uranium.	6
Uraninite	North Carolina	150.7	19.3	170.0	11.3	74.65	228
Do	Colorado	147.1	8.0	155.1	5.2	69.61	223
Gummite	North Carolina	126.7	20.3	147.0	13.7	65.38	225
Uraninite	Joachimsthal	131.8	7.8	139.6	5.6	61.74	226
Uranophane	North Carolina	108.0	9.7	117.7	8.2	51.68	228
Uraninite	Saxony	112.5	3.1	115.6	2.7	50.64	228
Uranophane	North Carolina	88.8	24.7	113.5	22.8	49.84	228
Thorogummite	do	61.1	11.8	72.9	16.2	33.17	220
Carnotite	Colorado	41.6	8.1	49.7	16.3	22.61	220
Uranothorite	Norway	24.9	0.3	52.2	1.3	11.39	221
Samarskite	North Carolina	23.2	0.16	23.4	0.7	10.44	224
Orangite	Norway	22.84	0.26	23.1	1.1	10.34	223
Euxenite	do	19.8	0.10	19.9	0.5	8.71	228
Thorite	do	15.6	1.0	16.6	6.2	7.54	220
Fergusonite	do	11.95	0.07	12.0	0.5	5.57	215
Æschynite	do	9.98	0.02	10.0	0.2	4.52	221
Xenotime	do	1.14	0.40	1.54	26.0	0.70	220
Monaxite	North Carolina	0.88	0.00	0.88	.....	0.43	205
Do	Norway	0.84	0.01	0.85	1.2	0.41	207
Do	Brazil	0.76	0.00	0.76	.....	0.31	223
Do	Connecticut	0.63	0.00	0.63	.....	0.30	210
Allanite	North Carolina	0.014	0.00	.....	.....	0.007	.....

Column 1 gives the activity of the emanation contained in 1 gram of the mineral.
Column 2 gives the activity of the emanation lost by 1 gram of the mineral at ordinary temperatures.
Column 3 gives the sum of the two previous activities (total emanation equivalent to the radium contained in 1 gram of the mineral).
Column 4 gives the percentage of the total emanation lost by diffusion from the cold mineral (the emanating power of the mineral at ordinary temperatures).
Column 5 (percentage of uranium) gives the weight (in hundredths of grams) of the uranium contained in 1 gram of mineral.
Column 6 gives the ratio of the radium to the uranium (the number obtained on dividing the total activity (column 3) by the quantity of uranium (column 5, percentage of uranium).

The three results in carnotite are, according to Mlle. Gleditsch, 234; to Boltwood, 220; to Strutt, 176. Mlle. Gleditsch's results are the latest. She has had the benefit of the experience of many workers since the pioneer work of Boltwood and Strutt, and her figures are therefore probably more nearly correct. They seem to be so considered by Rutherford,[2] who quotes them.

Rutherford [3] explains the lower radioactivity of carnotite thus:

The weight of pure radium per gram of uranium in a mineral in radioactive equilibrium should thus be a definite constant. This constant ratio Ra/Ur was determined by Rutherford and Boltwood,[4] who compared by the emanation method the quantity of radium in a mineral of known uranium content with the amount of emanation from a standard solution of radium. The amount of radium per gram of uranium was found to be 3.4×10^{-7} gram. This is expressed in terms of the radium standard used by the writer. Consequently, 1 gram of radium is present in a mineral containing 3,000 kilos of uranium.

Knowing the percentage of uranium in a given mineral, the amount of radium can be at once deduced without measurement. This is the first example of a case where the amount of one element can be inferred from the amount of another present.

In the formation of a uranium mineral it is probable that uranium is deposited without its products. Supposing that uranium changes into ionium and ionium into

[1] Boltwood, B. B., The origin of radium: London, Edinburgh, and Dublin Philoso. Mag. and Jour. Science, 6th ser., vol. 9, London, 1905, pp. 608–609.
[2] Rutherford, E., Radioactive substances and their radiations, G. P. Putnam's Sons, N. Y., 1913, p. 463.
[3] Op. cit., pp. 462–465.
[4] Rutherford and Boltwood, Am. Jour. Sci., 4th ser., vol. 22, 1906, p. 1. See also Boltwood, idem, 1908, p. 296.

radium, an interval of about ten million years will be required for the radium to reach a practical equilibrium with the uranium. In this calculation it is supposed that the period of ionium is not greater than one million years. If the period is only 100,000 years, one or two million years will suffice. The ratio Ra/Ur should thus only be constant for old minerals. It is to be expected that the ratio would also depend to some extent on whether the mineral has been altered by the action of percolating water or by other agencies. If one or more products are removed in this way the equilibrium is disturbed, and the ratio Ra/Ur will not be the same as for old unaltered minerals.

The first evidence of an effect of this kind was observed in a specimen of pyromorphite found at Issy L'Eveque and examined by Danne.[1] This contained a considerable quantity of radium but no uranium. Later investigation by McCoy[2] showed that the radium was confined to a surface layer which had been deposited by flowing water. The water had dissolved some radium in its passage through some uranium deposits in the neighborhood.

Recently attention has been drawn to a number of secondary minerals like autunite and chalcolite, where the ratio Ra/Ur is in some cases less than half the normal value.

While the average value Ra/Ur for a number of minerals is about the same as that found by Boltwood, some of the minerals—for example, the first six—give a value of the ratio distinctly below the normal, while the specimen of Cornwall pitchblende gives a high value of the ratio. Soddy and Pirret found the ratio Ra/Ur for autunite from Portugal to be 0.45 of that for Joachimsthal pitchblende. Marckwald and Russell examined specimens of autunite from Portugal and France, and found a ratio from 0.21 to 0.68 of the value for Joachimsthal pitchblende.

It should be pointed out that the minerals which give a low ratio Ra/Ur are believed to be of relatively recent formation and are secondary minerals; that is, minerals derived from the decomposition of primary uranium minerals. The low ratio Ra/Ur may be ascribed to one or both of two causes, viz, (1) to the recent formation of the mineral, or (2) to the removal of part of the radium by percolating water or other chemical agencies. If (1) is correct, it is to be expected that not only should the ratio be low for radium but equally so for ionium. This point has been examined by Marckwald and Russell,[3] who found the ratio Io/Ur for autunite to vary between 0.76 and 0.93 of the ratio for pitchblende. These values are distinctly higher than the corresponding ratios for Ra/Ur, viz, 0.24 to 0.68.

The evidence so far obtained is not sufficiently precise to distinguish between the two possible explanations. It seems, however, probable that the alteration of the equilibrium by the action of water is in many cases of paramount importance.

It is difficult to explain the relatively high ratio found by Mlle. Gleditsch for certain old minerals. If alteration has occurred, it is possible in some cases that the radium dissolved from one part of a mineral may be deposited in another, and this will temporarily disturb the values of the ratio. Examples of this have been observed by Mlle. Gleditsch.

Considering the chemical and other difficulties in determining accurately the relative amounts of radium or uranium in minerals, the evidence as a whole strongly supports the view that for *old unaltered* minerals the ratio Ra/Ur is a definite constant, with a value 3.4×10^{-7} by weight.

DOMESTIC URANIUM ORES.

CONCENTRATION OF CARNOTITE ORES.

One of the greatest problems met by the miner of carnotite ores is that of concentration. The ores are mostly very lean, and they have to be carefully hand-picked to bring them up to a quality that will justify shipping. From some claims in southwestern Colorado the ores after being sacked must be packed on horses or mules a number of miles to a wagon road, then hauled by wagon 50 miles to a narrow-gage railroad which carries them to Pueblo, where they are transferred to a broad-gage railroad and are shipped either to an eastern point of consumption or to a seaport, where the ore must be again

[1] Danne, Compt. Rend., vol. 140, 1905, p. 241. (See Strutt's table on a preceding page of this paper, F. L. H.)

[2] McCoy, Jour. Am. Chem. Soc., vol. 29, 1907, p. 1698.

[3] Marckwald and Russell, Jahrb. Rad., vol. 8, 1911, p. 457.

handled in transhipment to a steamer. So much handling means that only comparatively high-grade ores can be shipped. Probably no ores containing less than 2 per cent of uranium oxide (U_3O_8) and 3 per cent of vanadium oxide (V_2O_5) will pay for handling, particularly since the drop in the price of vanadium. To make the lower-grade ores into a product which can be mined and shipped at a profit has therefore been a tantalizing and attractive problem.

As has been stated, the carnotite and vanadium minerals are, especially in the leaner ores, interstitial between the sand grains, and so are in very thin films and particles. They are also brittle and soft, and slime easily.

Many attacks upon the problem were made by attempting to dissolve the minerals in various acids or alkalis. Most of these lost the radium, and buyers refused to take the concentrates without it; the cost of chemicals and their transportation was high; there was much destruction of chemicals by the gangue; and though plants were erected at several places, none succeeded.

Several years ago Henry E. Wood found that by crushing the ore, running it over concentrating tables, and saving the slimes he could about double the percentage of uranium and vanadium in the ore without a prohibitive loss. He has recently published [1] a note upon the subject in which he also brings in specifically the idea of agitation, though this was a necessary part of his former method.

Siegfried Fischer [2] has described the use of the same principle applied through different machinery. Mr. Fischer found from experiments upon small samples (50 to 100 grams) that he could concentrate carnotite ores about 3 into 1, but in his experiments he evidently crushed considerable sand, thus making silica slime. After crushing, the material is agitated and the carnotite is abraded from the sand grains by their rubbing against each other.

Mr. and Mrs. Henry Reams, at their claims on Mesa Creek, near Nucla, Montrose County, Colo., have independently devised a similar plan to be worked with simple machinery. The experiments were made by crushing low-grade ore and shaking it with water in glass fruit jars until the sand grains were clear and white. The slime is poured off and the water is evaporated from it, so that the radium is saved with all minerals which are interstitial or coat the sand grains. The accompanying illustrations show that the radioactivity of the untreated ore is preserved in the concentrates. (See Pl. I, *A* and *B*.) They were placed on cardboard laid on a sensitive plate covered with black paper for 24 hours. Unfortunately, the same quantities of ore and concentrate were not used, and there was somewhat more concentrate than ore. The results are of course only qualitative.

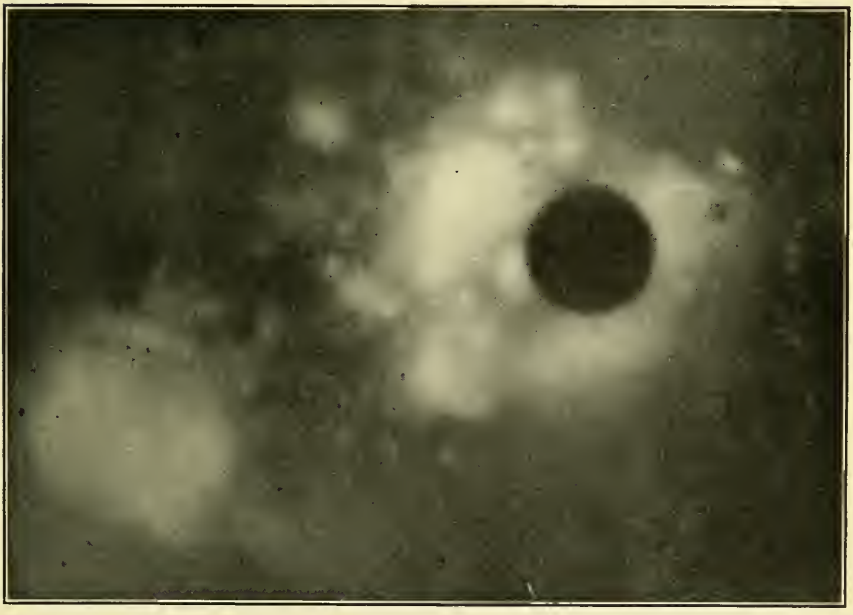
At the time of writing Mr. Reams was engaged in constructing a simple agitator for use on a larger scale.

All these processes depend on the abrasion of the mineral from the sand grains and its suspension in water. It is probable that similar results could be obtained by suspending the particles in air; that is, instead of abrading the sand grains in water an air current could be blown through the mass, removing the fine particles as they are made. Though this process would do away with possible losses of dissolved

[1] Concentration of pitchblende: Eng. and Min. Jour., vol. 95, 1913, p. 1165.
[2] The carnotite ores and some similar ores: Metall. and Chem. Eng., New York, vol. 10, June, 1912, pp. 356–359.

A. RADIOGRAPH MADE BY CONCENTRATE OF ORE FROM CLAIMS ON MESA CREEK, NEAR NUCLA, COLO.

Exposure four days. The concentrate is in the shape of a small block three-fourths of an inch thick.



B. RADIOGRAPH MADE BY ORE FROM CLAIMS ON MESA CREEK, NEAR NUCLA, COLO.

Made by covering the plate with black paper over which a thin sheet of pasteboard was laid; upon this the ore was placed and put in a dark room for four days.

and suspended matter, if the water were decanted, instead of being evaporated, the air blast would add to the cost and complexity of machinery.

The processes described are of course applicable to most vanadium and other minerals occurring in the sandstones as interstitial fillings or coatings of the sand grains, though similar experiments tried upon the roscoelite-bearing standstones were not successful. It may be, however, that better manipulation will enrich many of the low-grade roscoelite ores at a cost sufficiently low for them to be worked at a profit. It seems certain that some such process can be applied to the concentration of carnotite and the other minerals of the friable sandstones, and thus stop much of the economic waste involved in the rejection of mined low-grade ores and in the carriage of useless sand in the form of gangue over long, difficult, and expensive routes.

The United States Bureau of Mines has been studying the subject of the concentration of these ores and will undoubtedly throw much light on the subject in a forthcoming bulletin.

PITCHBLENDE.

During 1912 a small quantity of pitchblende was mined in the Calhoun mine near Central City, Gilpin County, Colo. It averaged about 37.5 per cent uranium, and was mostly sold for experimental purposes and for specimens. None is known to have been produced during the year from the Alps, Belcher, German, Kirk, or Wood claims, all located on Quartz Hill about 1½ miles west of Central City and in all of which pitchblende occurs with sulphides. The deposits have been described recently by Forbes Rickard from whose description the following excerpts are taken: [1]

QUARTZ HILL DEPOSITS.

Near the west end of Quartz Hill are several mines which have been known to produce pitchblende, usually in small quantity but of high quality in respect to uranium content. * * * Mr. Boltwood, of Yale University, in some notes referring to pitchblende occurrences in Joachimstahl (Bohemia), Cornwall (England), and Colorado, says that while "these localities have been known for the past twenty years, it is a very significant fact that, although a diligent search has been made for new occurrences over the whole surface of the earth for the past six years, no other important sources of supply have been discovered." This was written something like two and a half years ago, and there is no reason to believe that it does not apply at the present time.

The Kirk, German, and Wood mines, all on Quartz Hill, are among the more important and best known. There are several patented claims, on which a small amount of work has been done, that lie within a north-south belt less than 1,000 feet wide and possibly one-half mile long, which area includes all veins in any way identified with the production of pitchblende.

GEOLOGY OF THE DISTRICT.

This district is one in which gneiss and crystalline schist predominate, with numerous intrusive andesitic dikes of varying composition and texture; acid granitic dikes are less numerous, but their occurrence is important in this connection, for in association with the veins of these mines there occurs, in intrusive form, a fine-grained aplitic granite, which is closely associated with the pitchblende. This granite takes dike form, occasionally putting out tongues and more rarely taking the shape of connecting sills. That granite of this description is similarly identified with the tungsten

[1] Rickard, Forbes, Pitchblende from Quartz Hill, Gilpin County, Colo.: Min. and Sci. Press, June 7, 1913, pp. 851–856.

occurrence in Boulder County, Colo., has been established, and the following is a quotation from a communication from R. D. George, State geologist:

"The rock specimen * * * is a mashed granite in which the feldspars are quite largely kaolinized. The mica has been very largely, if not entirely, leached out, or in part changed to chlorite and in part distributed through the feldspars, where it appears to form both talc and chlorite. The rock is very similar to much of the fine-grained dike rock of the tungsten area. * * * The rock containing the pitchblende, galena, sphalerite, etc., is a fine-grained aplitic granite which probably once contained an appreciable amount of biotite in small flakes. It is a finer textured rock than the one just described and considerably more quartzose, although the proportion of quartz has been made greater by the disintegration and part removal of the feldspars. It is very likely that the chief difference between the rocks in their original condition was one of texture rather than composition. Both closely resemble the aplitic dike rocks or the fine-grained pegmatites of the tungsten area. The coarser is at present a little more like the tungsten rocks. I should have said that the rock with the pitchblende has been rendered much finer than it was originally by the process of granulation due to movement and fracturing."

The close identity of the granite rock in the pitchblende and tungsten areas of Gilpin and Boulder Counties, respectively, suggests that the mines of these two districts lie within the same petrographic province in relation to the main granite mass underlying.

Respecting the correlation of the rocks of this formation, Archean gneisses and crystalline schists are intruded by granitic dikes, and long subsequent to this belong the porphyry intrusions of the andesitic rocks. These later dikes are of the andesitic type andesites, quartz andesites, and dacites. In thin plates, examined under the microscope, they show a microcrystalline groundmass, with porphyritic feldspar phenocrysts, and much altered pyroxene. Nowhere in the mines, so far as mine workings have gone, do dikes of these two systems intersect.

The veins themselves without exception have a well-defined northeast-southwest trend. Similarly, without exception, the fine-grained granite intrusive is common to all sharing in the pitchblende distribution. It is significant that some intervening veins, yielding profitably gold-silver ores but not pitchblende, are bounded by walls of crystalline metamorphic schist, the granite intrusive being absent. This plainly suggests the derivation of the older fine-grained granite from a main mass, which in its intrusion into the fissures in the state of magma, favored some and not others of these veins.

THE ORE DEPOSITS.

Ore deposits of this district furnish two types of ore, one being characterized by pitchblende, with accessory pyrite in varying quantity, with sphalerite and galena in subordinate quantities, and sometimes marcasite and stibnite, but in much less degree; the other type of ore includes the minerals pyrite, chalcopyrite, sphalerite, and galena, with varying gold and silver content. Quartz is plentiful in the gangue. It is also often found lining vugs or cavities in the vein.

It is axiomatic in these mines that as pitchblende comes in the gold goes out, and, as a matter of fact, the pitchblende ores seldom contain more than $2 to $4 in gold. What gold is present is largely in metallic form, which makes it susceptible to concentration with pitchblende, making a comparatively high-grade product. To illustrate, the following products were obtained by pneumatic-jig treatment of a Wilfley table concentrate:

	Gold, per ton.	Silver, per ton.	Uranium oxide (U_3O_8).
	Ounces.	*Ounces.*	*Per cent.*
First-class concentrate	1.60	10.40	7.16
Final jig concentrate, exclusive of beds and hutch product	[a] 24.40	35.60	58.81
Beds containing fine gold	[b] 131.50	58.00	72.72
Hutch concentrate	50.50	40.50	64.29

[a] Including 9.87 ounces "metallics." [b] Including 81 ounces "metallics."

That these products represent a high ratio of concentration may be judged from the fact that the original crude ore from which these concentrates were derived assayed Gold, 0.60 ounce per ton; silver, 2.75 ounces.

* * * * * * *

PITCHBLENDE FROM GOLD MINES.

In former times these Colorado mines were worked for gold, and only in the past 15 or 20 years has the rare element uranium been generally recognized in the form of pitchblende and separately mined.

* * * * * * *

THE GERMAN AND BELCHER MINES.

The underground workings of the German and Belcher mines are connected at the first and second levels. As they are under the same ownership, they are worked as one mine. The pitchblende vein, as previously noted, is accompanied by a granite dike more or less shattered, and at times it occupies a position which is central in respect to the dike itself. The dike varies in width from 5 to 9 feet. The vein varies from 4 or 5 inches to 18 or 20 inches; it is generally marked by a narrow gouge or selvage on its hanging wall side. Veinlets extend from the vein proper into the fracture seams in the granite.

The more solid pitchblende, either in lens form or in a well-defined streak, seldom exceeds 3 to 4 inches in width. Where the vein reaches its maximum width, the proportion of uraninite is inversely small, though for the whole width (apart from the high-grade bunches) the vein carries sufficient pitchblende to constitute a grade of ore for concentration; from 2½ to 4 per cent U_3O_8. Concentration tests now in progress are proving satisfactory and give encouragement for the erection of a reduction plant on the mine premises.

Outside of the general policy of development adopted by the management, a small amount of pitchblende ore is being mined. By crude hand-sorting within the shaft house, there is now being produced, in small but increasing quantity, a selected grade of pitchblende carrying 15 to 60 per cent uranium oxide (U_3O_8). An average of approximately 30 per cent U_3O_8 is established and can probably be maintained in quantity of several tons per annum. The bulk of ore suitable for mill treatment accumulates in the proportion of something like 40 tons to 1 ton of "selected pitchblende."

These mines of Quartz Hill, though they may be small mines, have advantages over larger mines in other districts, in that: (1) There is no extensive faulting or dislocation of the veins; (2) no great investment is needed for a mill, or for railroad transportation; and (3) there is no extra pumping expense. While in the German mine, the partly massive pitchblende is streaked by pyrite, in the Belcher mine the reverse is true. These streaks run through the vein for practically the whole length of a stope, say 100 feet long, and at intervals enlarge into pockets of high-grade ore. The point of such enrichment corresponds with the swells in the vein itself. In both mines the gangue of the pitchblende vein is of pegmatic (pegmatitic) character; it is locally termed spar. Vein quartz, which is plentiful in the gold-silver vein, is not seen in association with pitchblende.

The gold-silver vein plainly belongs to a postmineral fracturing; that is to say, long subsequent to the building up of the pitchblende vein in association with the granite (aplitic), there was a fault movement along the plane of the vein which resulted in the reopening of the vein along lines approximating the northeast-southwest course of the already existing vein. Lines of least resistance would naturally govern in the creation of new channels for the later vein-forming agencies, and these have in the main followed the north or footwall side of the granite intrusive. While the gold-silver vein, in the main, occupies the footwall side of the mine, at a point between the German and Belcher shafts it crosses the pitchblende vein and diverges from it as it goes eastward. The gold-silver vein continues strong and productive beyond the intersection. The granite accompanying the pitchblende has a way of feathering out at times into the mica schist rock; and while nothing like dislocation or faulting of the granite has yet been observed, this may exist and will probably be found as mine work is extended. The gold-silver ore shoots have no definite boundaries and no great length, from 150 to 200 feet representing their longest development in any single stope. They tend to recur at regular intervals, separated by unproductive ground.

No placer pitchblende has been found in the vicinity, though * * * much placer work * * * and much surface work in pits and trenches has been done.

Mr. Rickard thinks that the lack of placer pitchblende is due to the fact that the veins did not reach the surface, but pitchblende is rather easily altered and would waste away quickly, as geologic time is measured.

URANINITE AND OTHER URANIUM ORES.

Pitchblende is amorphous and occurs in veins generally with sulphides. Uraninite is a crystalline variety which occurs in pegmatites. In the United States it is found sparingly in the Carolinas in the pegmatite dikes worked for mica and feldspar. None is known to have been recently produced in South Carolina, but in North Carolina small lots were saved at the Deer Park and Bailey No. 1 mines, at Penland; Eagle Bluff mine No. 1, near Mount Mitchell post office; Blue Rock mine, 7 miles southwest of Sprucepine; Beaver Creek mine, 3 miles northeast of Sprucepine; and Flat Rock mine near Sprucepine, all in Mitchell County. Small quantities are also found in the L. A. Berry, Wiseman, and Dake mines, near Sprucepine.

In all the mines the uraninite is partly or wholly altered to gummite, uranophane, and autunite.

Around a lustrous black core of uraninite, gummite forms an orange-colored ring and around that is another ring of bright lemon-colored uranophane. Many specimens have crystals of autunite imbedded on the outside of the uranophane and in the adjacent rock. In a few specimens the autunite shows a tendency to a radial arrangement. The autunite is evidently a comparatively mobile mineral, and is found in cracks at some distance from the pitchblende, gummite, and uranophane. A few flakes of torbernite were seen at the Bailey No. 1 mine.

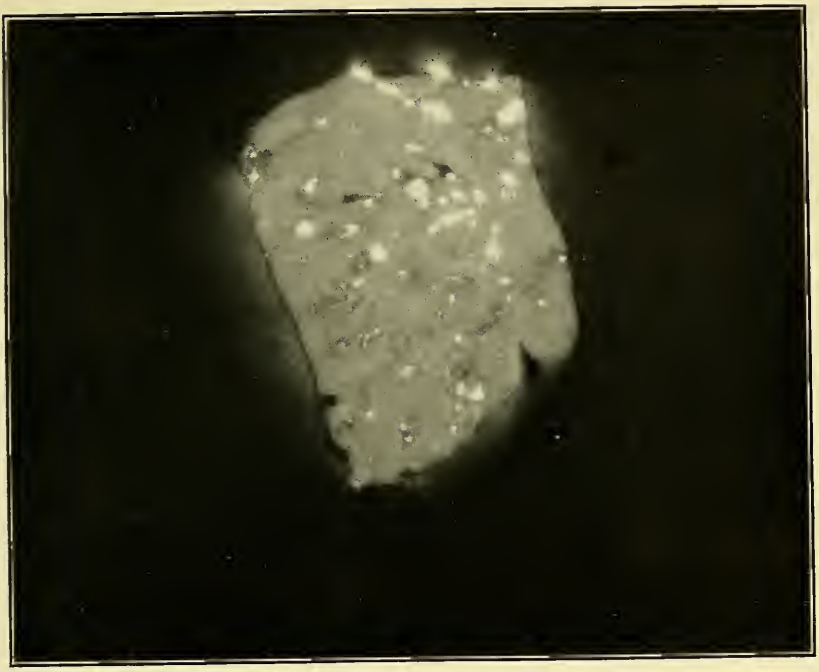
In some dikes the pitchblende is wholly altered to the oxidized minerals. In the dikes in which the rock-forming minerals are comparatively fresh the uraninite is least altered. In dikes that are softened by decay the uraninite may be entirely altered. Of those seen by the writer, the uraninite crystals reach possibly $1\frac{1}{2}$ inches in length and when broken or sawed across in order to show the contrasting colors of the minerals make handsome cabinet specimens.

Specimens from the Blue Rock mine, 7 miles southwest of Sprucepine, show pitchblende partly altered to gummite and uranophane, imbedded in cyrtolite, and a black mineral which may be samarskite, allanite, or some other one of the lustrous black minerals found in the pegmatites, pitchblende forming much the smaller part of the specimen. Only a visual examination could be made of the specimens, and as they showed no decomposition products they could not be identified.

Samarskite [1] which occurs with the uraninite is also a uranium-bearing mineral, and carries from 10.90 to 12.54 per cent UO_3, with tantalum, columbium, and rare earth metals. (See analysis on a preceding page.) Polycrase [1] with from 13.77 to 19.47 per cent UO_3, and fergusonite,[1] which generally contains some uranium, are also accompanying minerals, but in quantities so small that they are merely curiosities.

Probably the entire output from the various workings does not reach 100 pounds a year. Prices are a matter of individual bargaining, for there is no regular market. When radium was first discovered $10 a pound was offered for the uranium minerals, with the idea of getting the pegmatite miners to save the material. As soon as enough had been bought for experimental purposes, the price immediately dropped. During 1912 some was sold for approx-

[1] Dana's System of mineralogy.



A. RADIOGRAPH OF "FERGUSONITE" FROM BARINGER HILL, TEX., SHOWING LACK OF HOMOGENEITY IN THE SUBSTANCE.

B. RADIOGRAPH MADE BY LAYING A PIECE OF PITCHBLENDE UPON A PLATE HOLDER CONTAINING A SENSITIVE PLATE.

Exposure 24 hours.

imately $5 per pound and some for $1.50 per pound. It is probable that the higher price is casual and that the lower price is nearer what may be ordinarily obtained for fairly pure material.

A few crystals of uraninite have been found in pegmatite at Middletown, Glastonbury, and Branchville, Conn. A variety called nivenite occurs at Baringer Hill, Tex.

In the Baringer Hill dike are other uranium-bearing minerals—mackintoshite (21.86 to 22.40 per cent UO_3); thorogummite, said to be an alteration product of mackintoshite; polycrase and fergusonite.[1] The last mineral is not homogeneous, as is shown by a polished surface and beautifully so by its radiograph. (See Plate II, *A*.)

Sporadic occurrences of uraninite have been reported from other places in the United States, but they are very rare.

In the following table are given analyses of uraninite from American and the principal foreign deposits except the Cornish pitchblende, of which no analysis is available; also analyses of carnotites and new minerals of the calciovolborthite type from Utah.

[1] See Dana's System of mineralogy, and Hess, F. L., Minerals of the rare earth metals at Baringer Hill, Llano County, Tex.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 286–294.

Analyses of uraninite, carnotite, and calciovolborthite minerals.

	Uraninite.						Carnotite.					Calciovolborthite (?).	
	1	2	3	4	5	6	7		8		9	10	11
	Blackhawk, Colo.	Flat Rock, N. C.	Glastonbury, Conn.	Joachimsthal, Bohemia.	Johanngeorgenstadt, Saxony.	Lukwengule, German East Africa.	Roc Creek, Colo.	Recalculated.	Near Olary, South Australia.	Recalculated.	Tjuyamunite, Ferghana.	Richardson, Utah.	
UO_3	25.26	50.83	23.13	O 12.11	59.30	87.7	54.89	61.53	48.7	61.9	63.09		
UO_2	58.56	39.31	59.93	U 72.36	22.33								
V_2O_5					V_2O_5 WO_3 $MoO_3(?)$ 0.75		18.49	20.72	16.8	21.4	21..	30.6	16.0
MoO_3							.18						
TiO_2	Trace.						.03						
ZrO_2	7.59		.15		None.								
ThO_2		2.78	10.01		None.								
CeO_2	.22	.26	.29		None.								
$(LaDi)_2O_3$		.50	.15		None.								
$(YEr)_2O_3$		.20	.48		None.								
Bi_2O_3					0.75								
PbO	.70	4.20	3.08	5.09	6.39	7.5	.13		1.3	1.7			
CuO					0.17		.15					48.4	37.1
ZnO	.44												
Al_2O_3					(?) 0.20		.09		5.7				3.2
FeO	.32	Trace.		3.97		1.0							
Fe_2O_3			.28		0.21		.21		19.4			.8	.5
MnO	.16				0.09								
CaO	.84	.85	.17	1.14	1.00	2.1	3.34	3.03	1.0	1.3	6.38	3.9	15.3
SrO							0.02	1.03					
BaO							.90					2.7	2.3
MgO	Trace?	.30		2.32	0.17		.22	.25	Tracc.	Trace.		.3	.5
Alk.	Trace?				Na₂O 0.31		K_2O 6.52	7.31	5.2	6.6		.7	.2
							Na_2O .14	.15	1.8	2.3			
							Li_2O tr.						
H_2O	1.96	1.21	.43		3.17	0.5	105° 2.43	2.72		5.0	7.04	105°− 1.8	1.0
							350° 2.11	2.36				105°+ 6.4	4.3
N	.15	.37	2.41		0.02								
CO_2						(with H_2O)	.56					2.4	.9
SiO_2	2.79	.08	.15	3.91	0.50	0.3	.15					.6	.7
P_2O_5	.22	(?)	.02		0.06		.80	.90	Trace.	Trace.		.3	.8
SO_3					0.19		None.						
As_2O_5	.43				2.34		Trace.					1.1	17.2
$CuFeS_2$	.12												

FeS_2	.24												
Fl			.04										
Insol		.10	.85			0.2	7.10						
Total	99.95	100.99			97.95	99.3	98.46	100.00	99.9	100.2		100.0	100.0
All U as UO_2	82.36	87.31	81.75										
Sp. Gr	8.068	8.086	9.622		6.89	8.84							

1. Hillebrand, W. F., Occurrence of nitrogen in uraninite: Bull. U. S. Geol. Survey No. 78, 1891, p. 65.
The first analysis is the mean of two analyses of pitchblende from near Black Hawk, Colo. No test was made for lanthanum. The FeO was calculated from total iron after deducting that required by pyrite (FeS_2) and chalcopyrite ($CaFeS_2$), which are, of course, impurities. The gas determined as nitrogen was mostly helium, as afterwards discovered (in 1895) by Ramsay.

2. Idem. Uraninite from pegmatite dike, Flat Rock mine, near Sprucepine, N. C. The N. (helium, see note under 1) is the mean of 0.38 by fusion with $NaKCO_3$ and 0.35 by H_2SO_4.

3. Op. cit., p. 62. The UO_2 is the mean of 59.88, 60.07, and 59.83. The N. (helium, see note under 1) is the mean of 2.39 and 2.46 by decomposition with H_2SO_4 in sealed tubes, and 2.33 and 2.46 by fusion with $NaKCO_3$ in a current of CO_2.

4. Analysis by Ebelman, corrected by Blomstrand, Rammelsberg, C. F., Handbuch der Mineralchemie, pt. 2, 2d ed., Leipzig, 1895, p. 69. Pitchblende from Joachimsthal, Bohemia. The analysis is old, and if made in the light of present-day knowledge would undoubtedly show lead and helium. The insoluble contained 0.54 H_2O and 0.09 V_2O_3. The material was tested spectroscopically for helium.

5. Pitchblende from Johanngeorgenstadt, Saxony. Analysis by W. F. Hillebrand. New analyses of uraninite: Am. Jour. Sci., vol. 42, 3d ser., 1891, p. 391.

6. Marckwald, W., Ueber Uranerge aus Deutsch-Ostafrika: Centralbl. Mineralogie, 1906, p. 762.

7. Carnotite from Copper Prince claim, Roc Creek, Montrose County, Colo. Hillebrand, W. F., Contrlbutions to mineralogy from the United States Geological Survey: Bull. U. S. Geol. Survey No. 262, 1905, pp. 25, 27.

8. Crook, T., and Blake, G. S. On carnotite and an associated mineral complex from South Australia: Mineralog. Magazine, London, vol. 15, March, 1910, pp. 273–274.
In the original analysis the U is given as 47.8 and 60.8, respectively. It has been recalculated as UO_3 for convenience of comparison.

9. Nenadkevich, K. A., Tjuyamunite. A new species of mineral: Bull. Imp. Acad. Sci., St. Petersburg, 6th ser., Nov. 1, 1912, p. 946. (In Prussian.)

10 and 11. Hillebrand, W. F., analyst, Hillebrand, W. F., and Merwin, H. E. Two varieties of calciovolborthite (?) from eastern Utah: Am. Jour. Sci., vol. 35. April, 1913, p. 443.

No. 7 is a yellow-green mineral and No. 8 a green yellow. In No. 8 Al_2O_3 includes Mn_3O_4 and CO_3O_4 as weighed after precipitation together. Original condition unknown.

FOREIGN URANIUM DEPOSITS.

BOHEMIA.

Joachimsthal, Bohemia, is the most noted foreign locality from which uranium ores are obtained. The Joachimsthal district[1] lies on the higher southern slope of the Erzgebirge, southwest of its highest elevation, the Keilberg, near the Saxon boundary. The country rocks are mica schists. In the area cut by veins slaty mica schists predominate, with intercalated coarse-fibered mica schists, calcareous mica schists, and crystalline limestones.

Toward[2] the northeast and east gneisses occur, while toward the southwest the schist ends abruptly against granite, the northeast contact of the Great Eibenstock-Karlsbad massive of tourmaline granite, which crosses the axis of the Erzgebirge. At its border a contact zone is developed, which, however, does not quite extend into the Joachimsthal mineral-vein area. Numerous dikes of quartz porphyry, sometimes quite large and running northwest to north-northwest, traverse both the region northeast of the granite and the mineral area. Dikes of basalt and phonolite, as well as bosses of these rocks, were intruded in Tertiary time. The tremendous earthquake shocks that must have taken place during that period have left their record in wide fissures extending deep into the rocks, which must have remained open for long periods, since volcanic, phonolitic, and basaltic material, together with silicified deciduous trees—that is to say, débris washed from above—were found in the Joachimsthal deep levels within the so-called wacke lodes in mica schist, particularly in the Barbara drift, at a depth of 262 meters (859 feet). This remarkable fact was mentioned as early as 1557 by Mathesius, the preacher miner and reformer of Joachimsthal.

According to their strike, the silver-cobalt veins of Joachimsthal, especially those close to the town on the northwest, fall into these two groups:

(*a*) Morgengänge, striking east-northeast * * * and dipping north at 60–80°; (*b*) Mitternachtgange, striking north-northeast to north-northwest, for the most part, almost exactly north-south * * * and dipping at times 45–85° west or east.

Some of the lodes of the first group, for example, the Geyer and Mauritius veins, were very rich in the upper levels, but grew poorer in depth, so that they became of little importance in the modern mining period. On the contrary, some of the veins of the second group have in recent decades been worked by deeper drifts with success, particularly the Geistergang, which showed fine bodies of silver ore, especially in 1853; also the Rothe, Prokopi, Anna, Geschieber, Hildebrand, Junghaüerzecher, and Evangelisten veins.

The width of the veins varies between 15 and 60 centimeters and only exceptionally reaches 1 to 2 meters (3.28 to 6.56 feet). Stringers are common. Some of the Mitternacht veins reach the surface not as true veins, but as narrow, barren cracks.[3]

The filling is not the same in all the veins. Thus in the western Mitternachtgänge it is for the most part a brittle clay, with quartz and hornstone; in the eastern veins it is mostly calcspar and dolomite, while both sets of veins occasionally show a brecciated structure. The ores in these gangues form stringers, branches, and pockets that are very spotty. According to G. Laube, these ores may be divided into:

1. Silver ores (native silver, argentite, polybasite, stephanite, tetrahedrite, proustite, pyrargyrite, sternbergite, argentopyrite, besides rittingerite, acanthite, and cerargyrite).
2. Nickel ores (niccolite, chloanthite, millerite).
3. Cobalt ores (smaltite, as well as bismuth-cobalt-pyrite and asbolite).
4. Bismuth ores (native bismuth, as well as bismuth glance and bismuth ocher).
5. Arsenic ores (native arsenic, arsenic, arsenopyrite).
6. Uranium ores (pitchblende).

Galena, zinc-blende, pyrite, marcasite, copper pyrite, and bornite only occur subordinately and occasionally. Among these ores the cobalt and nickel ores appear to be on the whole the older, the silver ores the younger.

* * * * * * *

Near the lode fissures the country rock frequently has been impregnated with extremely finely divided ore particles. This explains the small percentage of metals

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[1] Beck, Richard, The nature of ore deposits, translated by W. H. Weed, 1905, pp. 282 et seq.

[2] Op. cit., pp. 284–287.

[3] Compare with W. P. Jenney, Mineral crest: Trans. Am. Inst. Min. Eng., vol. 37, p. 46; discussion, p. 1060.

shown by F. Sandberger and A. Seifert to exist in various rocks of Joachimsthal, especially copper, cobalt, nickel, and arsenic. In like manner the presence of minute granules of uraninm pitchblende in a scapolite-mica-schist of that locality, first discovered by F. Sandberger and conclusively confirmed by F. Babenek and A. Seifert, by means of large-scale ore concentration experiments, is most naturally explained by an infiltration from the lode fissures. Their presence as primary constituents seems to be gainsaid by their very unequal distribution in the rock. In the experiment just noted the dressing of 6,358 kilograms from a richer zone gave 226 kilograms of concentrates with a content of 0.3 per cent of uranic binoxide.

The veins traverse dikes of quartz porphyry, and in their turn are cut across by dikes of basalt and the wacke veins. However, since these wackes sometimes contain some interspersed argentite (earthy silver glance) where they cross the ore veins, it is inferred that at the time of the eruption of the younger volcanic rocks the vein formation had not yet been quite completed.

* * * * * * *

At the acute-angled lode crossings there has been an enrichment of the ore. The veins are richer in the porphyry and to the east in the limestone intercalation than in the schist.

The Joachimsthal mining industry began, according to G. Laube, at the end of the fifteenth or in the early years of the sixteenth century. As early as 1517 a mining settlement existed in the valley, and as early as 1518 the first "Joachimsthaler" were minted, this coin being now known as the thaler. In 1520 the settlement obtained the privilege of a free mining town. The total output for the first 44 years is put at 40 tons in gold—that is to say, over 4,000,000 gulden, reckoning silver at the value prevailing at that time. After 1545 the industry suffered a great decline, but acquired new vigor when the cobalt and bismuth ores became valuable. In recent time the industry has languished because of the depreciation of silver. During the last decade, special attention has been paid to the extraction of uranium, for which a Government factory has been set up at Joachimsthal. In 1898, 50.9 tons of uranium ore was obtained.

Pitchblende is also found across the Erzgebirge in Saxony, a short distance northwest, at Annaberg and Johanngeorgenstadt. Beck [1] gives a description of the deposits at Annaberg, based upon a monograph by H. Müller,[2] as follows:

"In this vein area the rock consists mainly of gray gneiss (the "bi-micaceous principal gneiss" of the geologic map). The district forms the southwest part of the Annaberg-Marienberg gneiss dome. In this dome, at the southwest periphery of the area, at Buchholz, a granite stock is exposed, from which a tongue of fine-grained granite (porphyritic microgranite) runs through the mineralized district northeastward in the form of a dike. Similar smaller dikes of this rock have been met with at several points above ground and underground. At the northeast edge of the field, at Wiesenbad, in the valley of the Zschopau, the erosion of the river has laid bare an intrusive stock of granite, so that this rock may be presumed to be rather widely distributed in the deeper levels of the mining area. Furthermore, mining operations very frequently encounter narrow dikes of lamprophyre (fine-grained mica syenites and mica diorites), at times also basalt dikes. The latter are genetically connected with the sheet of leucite basalt, which, resting on a substratum of fluviatile clays, gravels, and sands of the Oligocene, forms the tomb-shaped Pöhlberg immediately southeast of Annaberg.

More than 300 veins traverse the rocks near the town and in the district about it. They may be divided according to age into two groups. Of the older it may suffice to mention briefly the tin lodes of the former Alte Thiele Fundgrube near Bucholz and the pyrite blende lead veins, which, because of their unusual richness in copper pyrite and other copper ores, were worked in the Sanct Briccius, Heilige Dreifaltigkeit, Weinkeller, Rothe Pfütze, and Spanier mines on the east slope of the Pöhlberg and at several other points. The strike of these veins is usually about east-west. They have always proved to be younger than the lamprophyres, but older than the basalts.

On the other hand, the younger group consists of the silver-cobalt veins, in which we are here especially interested, and of examples of the iron and manganese veins which are developed farther southwest in the region of Scheibenberg. The silver-cobalt veins are the most important ore deposits of the Annaberg field.

* * * * * * *

The silver-cobalt veins occur in two principal series, whose directions intersect at nearly right angles. Most of them strike north-northwest, a less number strike east-

[1] Op. cit., pp. 287–290.
[2] Die Erzgänge des Annaberger Bergrevieres: Geol. Survey, Leipzig, 1894.

northeast to east-west. Only a few have a diagonal strike of north-south to north-northeast. The north-northwest veins belong exclusively to the silver-cobalt class; the veins of other courses are in part of different characters and age. The veins of the north-northwest series have usually a steep dip, those of the east-west series have a dip of but 45°–60° in different directions. Most of the veins have been followed for a horizontal distance of 800 meters (2,624 feet), some much farther, the Treue Freundschaft Stehende at least 2 kilometers (1.2 miles). On the other hand, mining operations on these lodes have penetrated to no great depth, the deepest, about 400 meters (1,312 feet), being in the Erstneuglück Flachan and the Heynitz Flachan. The thickness varies between 10 and 20 centimeters, in exceptional cases amounting to 2 meters (6.5 feet).

The vein filling consists mainly of barite, fluorspar, quartz, and brownspar with various cobalt, nickel, and bismuth ores, especially chloanthite, smaltite, gersdorffite, annabergite (nickel-ocher), and native bismuth, rarely bismuthinite, rich silver ores, especially pyrargyrite, proustite, argentite, earthy silver glance, native silver, silver chloride, and finally pyrite. The subordinate gangue minerals include hornstone, chalcedony, amethyst, calcspar, aragonite, kaolin, lithomarge, gypsum; among the ores are copper pyrite, galena, zinc-blende, marcasite, gray copper, siderite, uranium pitchblende, uranochalcite, gummite, zippeite, native arsenic, with others of minor interest.

An interesting feature of the veins is the occurrence in former times of great masses of silver chloride; for example, in the sixteenth century, in the Himmlisch Heer vein, masses of pure horn silver were found as much as 20 pounds in weight.

The veins are frequently filled with fragments of country rock and the brittle inter-vein rock and attrition clays. Argentiferous vein clays have sometimes been mined. The prevailing structure of the vein filling is irregularly massive.

According to H. Müller, the result of more than 200 observations showed as a rule a definite succession in the deposition of the minerals of these Annaberg silver-cobalt veins, which he summarized as follows:

V. Decomposition products, such as annabergite and cobalt efflorescence.
IV. Rich silver ores and native arsenic.
III. Calcspar and uranium pitchblende.
II. Brownspar and cobalt-nickel-bismuth ores.
I. Barite, fluorspar, and quartz.

I and II together always form the bulk of the filling.

As already stated, the silver-cobalt veins cut through the tin-bearing and pyritic lead veins, as well as the dikes of microgranite and lamprophyre. The basic dikes are often accompanied by silver-cobalt veins. Thus the Heynitz Flache vein follows a lamprophyre dike 0.1–3 meter thick for almost 600 meters along its strike and to a depth of 340 meters. It follows first one wall, then the other, and in places crosses the dike. On the other hand, both this and other examples of this type of vein are cut across by basalt. The basalts encountered in the mines not only form the true dikes, but also occur as vertical chimneys or pipes of round cross section. As rich silver ores occasionally occur interspersed in fissures in the midst of the basalt mass near vein crossings, as at Oberwiesenthal, it is inferred that chemical transpositions of the metallic compounds took place even later on.

Silver-cobalt veins and simple cobalt veins accompanied by pitchblende occur at Johanngeorgenstadt [1] also.

At the Fastenberg the Eibenstock tourmaline granite is concealed by a cover of phyllite, which it has altered by contact metamorphism into spotted slate and andalusite-mica rock. These contact rocks are traversed by many dikes of fine-grained granite. Numerous mineral veins form a dense network in this rock, some belonging to the tin-cobalt and some to the silver-cobalt formation, as well as pure cobaltic veins, all showing but little uniformity in strike. The veins are cut off by a vast network of iron-ore stringers, the so-called Faule (rotten lode). The filling of the silver-cobalt veins of this locality is similar to that at Annaberg. They are often rich in uranium pitchblende.

Johanngeorgenstadt, the youngest mining town of the Erzgebirge, was founded as late as 1654 by the Protestanta who were driven out of Bohemia, but mining began a few years earlier. It still continues, and produced in 1901 9 tons of bismuth and uranium ores.

The production of pitchblende in Austria is all from three mines, the State mine at St. Joachimsthal, the Sächsisch-Edelleutstollen

[1] Op. cit., pp. 291–292.

Gewerkschaft, and the Hilfegotteszecher Gewerkschaft in the R. B. A. Bezirke Elbogen. It has been repeatedly stated that the last two mines have been purchased by the Austrian Government.

The production since 1897 is given below. It will be seen that a climax in production was reached in 1900, and that since that year there has been a steady decline.

Production of pitchblende and radium in Austria (Bohemia), 1897 to 1911.[a]

Year.	Pitchblende.		Radium chloride ($RaCl_2$).	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Grams.*	
1897	48.9	$21,830	.....	.....
1898	56.2	25,084	.....	.....
1899	54.5	21,742	.....	.....
1900	57.4	32,753	.....	.....
1901	53.3	38,219	.....	.....
1902	51.2	38,495	.....	.....
1903	49.7	17,279	.....	.....
1904	19.0	41,583	.....	.....
1905	18.0	54,253	.....	.....
1906	17.8	53,155	.....	.....
1907	12.4	39,212	.....	.....
1908	10.1	29,852	.....	.....
1909	8.9	26,702	.....	.....
1910	7.2	19,693	0.9483	$60,900
1911	6.4	17,171	[b] 2.647	214,928

[a] Statistik des Bergbaues in Österreich, Wien, for various years. The production of radium is given only for the years 1910 and 1911.

[b] 14.146 grams radium preparations equivalent to 2.647 grams $RaCl_2$.

The percentage of uranium in the pitchblende is not given.

CORNWALL.

In Cornwall pitchblende has been found in many of the mines in the tin region, and the association as at Joachimsthal and Johanngeorgenstadt is with nickel-cobalt bearing veins, though only part of the veins are highly argentiferous. In Cornwall these veins are closely connected with the tin veins, and though apparently not exactly of the same age as the tin veins, they belong to the same general period of mineralization and vein formation. J. H. Collins [1] gives the following list of mines in which pitchblende had been found: Huel Edward, St. Just, Botallack, Huel Trenwith, Huel Province, Wherry mine, Tincroft (with autunite), Huel Bassett, Huel Buller, Tolcarne, Ting Tang, Pedn an Drea or Pednandrea (mammillary), Roskrow or Roscrow United (also known as South Tresavean), Ponsanooth, St. Austell Consols, Treemoor, and Withiel. Autunite and torbernite were also known to occur in some of these and other mines.

To this list Ussher, Barrow, and MacAllister [2] add the South Terras, which has been and still is the most important producer of pitchblende in Cornwall; Hill and MacAllister [3] add Carharrack, Dolcoath, Wheal Unity,[4] Wheal Gorland, and Wheal Lovell. The

[1] A handbook to the mineralogy of Cornwall and Devon, 1871, p. 78.

[2] The geology of the country around Bodmin and St. Austell; Mem. Geol. Survey England and Wales, London, 1909, p. 157.

[3] The geology of Falmouth and Truro and of the mining district of Camborne and Redruth: Mem. Geol. Survey England and Wales, 1906, pp. 179–180.

[4] Wheal or huel is an old Cornish word for mine.

occurrence of "uranium ores" in minerals not definitely indicated is also noted in a number of other mines, as is the occurrence of autunite, torbernite, and uranium ocher.

The general relation of the uranium-bearing veins to other veins is thus described by Ussher, Barrow, and MacAllister: [1]

Throughout the region, with the exception of the district in the eastern part of the map, there occur here and there lodes younger than those of tin or copper. These lodes are probably of different ages, but their association with the mineral district as a whole makes it probable that they are genetically connected with the eruptive after-actions following the intrusion of the granite and elvans ["elvans" is a local term for granite porphyry dikes. F. L. H.]. Some of these lodes contain minerals which also characterize tin lodes, such as arsenic and copper, and in small quantities, uranium, cobalt, and nickel ores. The younger lodes have been formed in fissures crossing the tin and copper lodes, and in bearing they vary from due north and south to a northwesterly direction, similar to the cross courses.

Of the younger lodes there are two well-marked series, those containing uranium and nickel ores, and those which have yielded considerable quantities of iron ore and some manganese. In addition to these argentiferous galena also occurs, sometimes with zinc and iron pyrites in lodes the bearing of which is varied, but is frequently either north and south or in directions similar to those of the tin and copper lodes.

Hill and MacAllister [2] give the following notes upon the occurrence and association of pitchblende and other uranium minerals in the Camborne-Redruth mining district:

In South Tresavean mine kupfernickel occurred with uranium, silver, and lead ores,[3] and at Roskrow United mines (near Ponsanooth) nickel was found with silver, copper, and uranium ores, and sulphide of iron.

The pitchblende [4] of Wheal Buller and Carharrack is said to have been phosphorescent. Uranite also was found in the mines at Ting Tang, Tolcarne, Wheal Gorland, Wheal Unity, Tincroft, Wheal Buller, and Pedn an Drea. Compounds of uranium with phosphorus and copper occurred in South Wheal Basset. Uranium ochre occurred at Carharrack and in Wheal Buller. Pitchblende was found in Ting Tang and Tolcarne mines.[5] Phillips states that oxide of uranium and pitchblende was found at 30 fathoms from surface in Tolcarne mine.[6] Uranium ores occurred in Tincroft and Gunnis Lake mines with wolfram and copper.[7] At Dolcoath pitchblende occurred with bismuth and cobalt ores and fluorspar.[8] Uranite (phosphate of uranium and lime) occurred in West Wheal Basset. Uranium ore with arsenical and cobalt ores were found in Herland mine,[9] (Gwinear). Pitchblende occurs at Wheal Basset, Wheal Unity, Wheal Gorland, and Tincroft. Its occurrence at East Wheal Lovell has been remarked by Mr. Cunnack.[10]

They also note [11] that East Pool and Wheal Agar had produced one-half ton of uranium ore.

The South Terras mine which, as stated before, has been the largest producer of pitchblende, is situated in the valley of the Fal, 5 miles west of St. Austell. The country rock is slate, intruded by greenstone and granite porphyry dikes.

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[1] Op. cit., p. 134.
[2] Loc. cit.
[3] R. Pearce, Note on Pitchblende: Trans. Roy. Geol. Soc. Cornwall, vol. 9, 1864, p. 102.
[4] J. Garby, A catalogue of minerals found in Cornwall with their localities: Trans. Roy. Geol. Soc. Cornwall, vol. 7, 1846, p. 86.
[5] This seems to be a misquotation. Garby says that phosphorescent "chalcolite-uranite" was found.
[6] On the oxides of Uranium: Trans. Geol. Soc. London, vol. 3, 1816, p. 112.
[7] Carne, Joseph, On the relative age of the veins of Cornwall: Trans. Roy. Geol. Soc. Cornwall, vol. 2, 1822, p. 104.
[8] Pearce, Richard, Note on pitchblende in Cornwall: Trans. Roy. Geol. Soc. Cornwall, vol. 9, 1878, p. 103.
[9] Dr. Berger, On the physical structure of Devonshire and Cornwall: Trans. Geol. Soc., vol. 1, 1811, p. 170.
[10] Discussion on Foster's paper, "New mineral localities," Min. Mag., 1877, No. 3.
[11] Op. cit., p. 291.

Collins [1] describes the mine as follows:

The uranium or "Jim" lode is not far from the same run as the iron lode, although no direct continuity has yet been proved. Its course is very nearly north and south; it crosses the low ground at the foot of the hill on which the ancient earthwork known as Resugga Castle stands, and it appears to be in line with the lead and blende lode which has been worked as the Crow Hill mine, though here again no continuity has been proved. This lode is certainly one of the most important deposits of uranium ores yet discovered anywhere in the world, and if and when there is a greater demand for uranium products per se at anything like the prices which have prevailed during the past 25 years, I think it must become a very valuable property.[2] Uranium ores were discovered at South Terras more than 40 years ago. At that time they occurred only as green and yellow oxidized products on the "back" or outcrop of the lode, which there traverses a dark brown killas. Work was at first carried on with much mystery; the green and yellow portions were hand selected, packed in barrels, and sold through an agent to German buyers.

In the year 1889 I was called upon to inspect the property, which was then or had recently been producing, besides the mysterious "Green Jim," rather considerable quantities of magnetic iron ore, also smaller quantities of ochre, copper ore, and tin ore. Statistical particulars of these will be given in Part II. I shall here confine my remarks to the uranium deposits, which were soon after my visit boomed in the newspapers throughout Europe and the United States for all they were worth and more. My report was as follows: "The Jim lode is from 2 to 4 feet wide. Only a small leader, however, consists of this valuable ore (of uranium). Up to the present the leader has been traced for about 150 fathoms, varying from a mere knife-edge up to 7 or 8 inches in thickness. The ore occurs in beautiful light-green, yellow, and brown flakes, scales, and crystals, mostly as phosphates of uranium, copper, and lime (autunite and torbernite), or as the hydrated oxide known as zippaeite.[3] So far the ore is altogether light and friable, and much of it is lost in the process of hand picking. Some specks of the hard and heavy pitchblende have, however, been seen, and as the works are carried down below the water level it may fairly be expected that a larger proportion of pitchblende will be found. A level has been driven in this lode for a distance of 150 fathoms, and in all, counting several small stopes above the adit, about 400 fathoms of lode have been taken away, working with only four men. This, according to statements made to me by the representatives of the owners, has yielded about 50 tons of hand-picked ore, of which 10 tons have been consigned to the selling agents since June 1, and a further quantity of 5 to 6 tons is still on the ground. * * * The ore sold has realized an average value of £40 per ton, the first quality running as high as £280 and the lowest £22. Perhaps an equal quantity has for the time been lost in the retuse, most of which could be recovered by a proper system of local chemical treatment at a good profit.[4]

I need not enter into the vicissitudes of this mine, worked as it was by different companies and under different names during the next 18 years. In September, 1907, having been again called in to inspect, I reported upon the uranium lode as follows: "The uranium lode is from 2 to 4 feet wide, and there is a more or less continuous leader of valuable ore, varying from a mere knife-edge up to a foot or more in thickness. The workings have now reached a depth of 30 fathoms below the adit level, and only pitchblende is now found in the lode, so that it is easy by hand selection to separate the high-grade ore, while the remainder can readily be 'dressed' in the ordinary way (by crushing and wet concentration). The 30-fathom level has now been driven for a total length of nearly 80 fathoms, and the ground thus opened up between this and the 20-fathom level is certainly not likely to yield less ore for equal length than that already yielded between the 20 and the 10, or between the 10 and the adit.

As illustrating the value of the ore ground, it would appear that up to the present about 1,000 fathoms of ore ground have been stoped away above the 20-fathom level and 500 tons of ore sold for approximately £20,000, while there is probably at least £5,000 more recoverable from the dumps. Thus each fathom of lode worked has been worth more than £16, a truly remarkable result for a lode averaging less than a yard in width."[5]

Other workings in the mine have been carried down to a depth of 50 fathoms below adit, but the uranium lode workings have not yet been communicated therewith.

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[1] Collins, J. H., Observations on the west of England mining regions. Plymouth, 1912, pp. 241-244.

[2] I say nothing of its radium content, as I have no special information thereon; but it has been stated that contracts have been made for the supply of radium in large quantities.

[3] This seems to be a slight slip. Zippeite is given by Dana (System of Mineralogy, 6th ed., 1909, p. 978) as a sulphate.

[4] Extracts from a report made by the writer, and dated Aug. 2, 1889.

[5] Further recommendations were then made, to which it is not necessary here to refer.

Ussher, Barrow, and MacAllister state that "between the years 1890 and 1903 over 440 tons of uranium ore were raised, realizing about £18,000. In 1901, 79 tons, realizing £2,923, were raised," and 576 long tons of uranium ore had been produced in the St. Austell-Bodmin area up to 1906;[1] but Collins[2] claims that the South Terras mine had produced nearly 1,000 tons of uranium ore, presumably up to 1911, at prices varying from £20 to £100 per ton.

A prospectus of the Radium and Uranium Syndicate (Ltd.) is quoted by Ussher, Barrow, and MacAllister[3] to the effect that assays "show that the so-called 'green ore' contained 6.2 per cent of uranium oxide, while the 'dark ore' contained 36 per cent of the same." These are the only data at hand about the richness of the ore, and no analysis of Cornish pitchblende is known to have been made, although all other known pitchblendes and uraniumites have been analysed repeatedly.

In March, 1911, the mine, which included the Resugga, Tolgarrick, and Carwalsick sets, with all appurtenances, was sold at auction for £3,100,[4] and has for part of the time since been operated for pitchblende as a source of radium.

The Trenwith mine was mined for pitchblende by the St. Ives Consolidated Co., and radium was made by a subsidiary company, the British Radium Corporation, at Limehouse, London, under the scientific direction of Sir William Ramsay.[5] The company is stated to have made a considerable quantity of radium salt, much of which is still on hand.[6]

From 1901 to 1912, inclusive, the output of uranium ores in Cornwall has been as follows:[7]

Production of uranium ore in England (Cornwall), 1901–1912.

Year.	Short tons.	Year.	Short tons.	Year.	Short tons.
1901	88	1905	115	1909	7
1902	58	1906	12	1910	85
1903	7	1907	80	1911	75
1904	None.	1908	80	1912	47

No data are given to show the uranium content of the ore and the figures therefore have little definiteness.

SOUTH AUSTRALIA.

The occurrence of pitchblende in Australia is, so far as is known at the present time, questionable. A float specimen the origin of which could never be satisfactorily determined was at one time reported, and pitchblende has been casually reported as occurring with wolframite at Wolfram Camp, 40 miles northwest of Mareeba, Queensland,[8] but the report lacks detail and confirmation.

[1] Op. cit., p. 135 and 157.
[2] Op. cit., p. 584.
[3] Op. cit., p. 157.
[4] Collins, J. H., op. cit., p. 607.
[5] Min. Magazine, London, vol. 5, Sept., 1911, p. 238.
[6] Salomans, David, Letter to the Times, London, quoted in Min. Jour., London, vol. 100, 1913, p. 245.
[7] Mines and Quarries: General Report with Statistics, Home Office, London, for various years.
[8] Correspondent, Mining in Queensland, northern fields: Australian Min. Standard, Apr. 4, 1912, p. 307.

RADIOGRAPH MADE BY PIECE OF URANIUM ORE FROM OLARY, SOUTH AUSTRALIA

The bright crooked streaks are made by carnotite filling cracks. The other bright spots are made by an unidentified mineral. Specimen in direct contact with plate for five days. Plate intensified.

In South Australia uranium ores have been found in some quantity at two places. One locality is at Radium Hill, 20 miles east-southeast of Olary Station, on the Petersburg-Broken Hill Railroad, and about the same distance west of the New South Wales boundary line. It is approximately 140° 40′ E. longitude and 31° 20′ S. latitude. The other locality is between Mounts Painter and Pitt in the Flinders Range, in about 139° 25′ E. longitude, 30° 30′ S. latitude. It is about 80 miles a little south of east from Farina station on the Great Northern Railway, and perhaps 30 miles northwest of Lake Frome.

The Olary locality presents much interest to the mineralogist. It was discovered in 1906, and according to H. Y. L. Brown [1] consists of two lode outcrops of a dikelike character more or less parallel and 25 to 45 feet apart. The width of one lode is given as 2 to 3½ feet, and in a report by C. E. Johnson [2] one lode is said to have been traced for a length of 1,825 feet and several parallel lodes have been found. The lodes traverse a country rock of gneissoid micaceous granite and granite schist into which dikes of granite and diorite have been intruded.

Brown says [3] that "the ore occurs as yellow and greenish-yellow incrustation and powder on the faces, joints, and cavities of a lode formation, which consists of magnetic titaniferous iron, magnetite, etc., and quartz in association with black mica (biotite)."

Specimens of the lode received by the present writer correspond closely to the description given by Brown, and seem to be part of a pegmatite, so that the lodes are probably pegmatite dikes. The rock is, however, much more complex than indicated by Brown. It was examined in part by Crook and Blake [4] and they note the presence of rutile carrying "about 3 per cent iron oxide and about 1.5 per cent vanadic oxide." In what appeared to be an intimate mixture of rutile, ilmenite, and magnetite, they also found by microscopic examination, supported by chemical work, a mineral they supposed to be tscheffkinite, possibly a silicotitanate of the rare earths which is apparently always an alteration product.[5]

Apparently the only uranium mineral found is carnotite, which occurs along cracks. In a polished specimen in the possession of the writer, a radiograph seems to indicate the possibility of even greater complexity, though opportunity for close study has not been had. In the radiograph (see Pl. III) the dark spots indicate quartz and ilmenite, the white streaks carnotite along cracks, and the light blotches rutile (?) with cores of ilmenite (?).

Brown [6] reports that an assay on material collected by him showed a content of 0.28 per cent uranium oxide (U_3O_8). As the result of a test on a long ton of material, probably picked, S. Radcliff [7] is quoted as saying that 30 pounds of uranium oxide per ton could be recovered. This is equal to 1.32 per cent. The Radium Hill Co. was organized to take over the property and to isolate the

[1] Brown, H. Y. L., quoted by L. C. E. Gee, the occurrence of uranium (radioactive) ores and other rare metals and minerals in South Australia: Dept. Mines, South Australia, Adelaide, 1911, p. 9.
[2] Quotation in op. cit., p. 11.
[3] Loc. cit.
[4] Crook, T., and Blake, G. S., on carnotite and an associated mineral complex from South Australia: Mineralog. Mag., London, vol. 15 (March), 1910, pp. 272, 279–284.
[5] Dana's System of mineralogy, 6th ed., 1909, p. 718.
[6] Op. cit., p. 10.
[7] Min. Jour., London, vol. 92, March, 1911, p. 268.

radium salts. They built a radium extraction works at Woolwich (Sydney) New South Wales, and up to the end of 1912, 10 milligrams of radium bromide had been prepared and another lot of 10 milligrams was practically ready for the market. It was claimed that 90,000 tons of ore were in sight.

The South Australian Radium Proprietary is mining on claims northeast of the Radium Hill Co.'s property.

At Mount Painter the country rock is said by L. K. Ward [1] to be altered sedimentary rocks carrying corundum, apatite, and monazite; in part, probably of Cambrian age, and intruded by many igneous rocks.

Secondary uranium ores, mostly autunite and torbernite, have been found at a number of places in the neighborhood of Mount Painter in highly ferruginous deposits which appear from the description to be veins in crushed granite and gneiss closely connected with pegmatite dikes, and in fact Ward states that at one place torbernite is found in pegmatite.[2]

The principal occurrences of the uranium minerals have been prospected by workings numbered from 1 to 6. Nos. 1 to 3 are on a prominence known as Radium Ridge; Nos. 4 and 5 on a hill close by known as Mount Gee, and No. 6 on a spur from the main ridge. No. 6 is the largest individual deposit and is situated on a ridge half a mile south of Mount Gee, and is nearly 500 feet long,[3] by 60 feet wide.[4] The outcrop shows hematite,[5] quartz, quartzite (sic), and a little psilomelane. On the south side are spurs from the main mass, one of which contains veinlets of torbernite and autunite. Workings have shown the following gangue minerals in the veins—quartz, hematite, a carbonate of the calcite group, fluorite, barite, and psilomelane. Imbedded in them are fragments of the country rocks, fergusonite, monazite, torbernite, autunite, uranophane, gummite, uranium ocher, and carnotite.

Fergusonite is in other places, so far as the present writer is aware found only in pegmatites; and monazite is found either in igneous or regionally metamorphosed rocks, in many pegmatites, and probably in no other place in veins unless in the transitional phases between pegmatites and quartz veins. It seems that these deposits are therefore phases of pegmatites.

Efforts have been made by the Radium Extraction Co. to work the deposits for radium and uranium, but so far without much success, as the deposits are very lean, carrying only 0.2 to 0.5 per cent uranium trioxide (UO_3).[6] The monazite present would not be of commercial value even if in large quantity, as it carries only 1.5 per cent of thoria.

SWEDEN.[7]

In the Silurian limestone and alum shales of Västergötland and Nerike districts, south central Sweden, a little-understood carbonaceous substance called kolm occurs in ellipsoidal masses "some

[1] The Mount Painter district: Review of mining operations, State of South Australia, half year ended Dec. 31, 1912, p. 27.
[2] Op. cit., p. 30.
[3] Loc. cit.
[4] Brown, H. Y. L., quoted by L. C. E. Gee, op. cit., p. 4.
[5] Ward, L. K., loc. cit.
[6] Min. Jour., London, Mar. 28, 1911, p. 27.
[7] Sjögren, Hj., Om framstallning of radium ur kolm från Västergotland och Nerike och om distillationsprodukterna af bituminös alunskiffer, Preliminört meddelande: Arkiv för Kemi, Mineralogi och Geologi, Stockholm, 1905, Band 2, Häfte 1, No. 5, pp. 1–6. The data presented are taken from this article.

decimeters thick." Kolm seems to be especially plentiful in the shales and limestone at Ulunda and neighboring places on a broad flat-topped high hill known as Billingen. It lies a short distance directly west of Sköfde and about 170 miles southeast of Stockholm. The kolm contains combustible matter which has about the composition of that in anthracite coal, one analysis giving about 5 per cent oxygen, 88 per cent carbon, and 7 per cent hydrogen. There was 22 per cent of ash in this specimen. Ash forms from 16 to 56 per cent of the kolm, and uranium oxides form from 1 to 3 per cent of the ash. The ash is composed mostly of silica, alumina, and iron oxide, but it also contains in small quantities manganese, magnesium, calcium, the alkalies, sulphur, nickel, cobalt, copper, molybdenum, vanadium, traces of cerium and gadolinium earth metals, titanium (sometimes more than 1 per cent TiO_2) barium, bismuth, antimony, lead, tin, and lithium. The last six are in very small quantity, but are regarded as characteristic constituents.

The alum shale also contains nodules (orsten) of calcite, of pyrite, and of barite.

Investigations showed that the kolm could not be commercially utilized for uranium and radium alone, and at the time Sjögren wrote, further investigations were under way to see if the shale could not be utilized as are the kerosene shales of Scotland, and thus make a number of products pay for the cost of quarrying and treatment.

A few uranium-bearing minerals are found in pegmatite dikes in Sweden, but none that are of importance as a source of uranium or radium.

NORWAY.[1]

Uranium-bearing minerals are found in the pegmatites of southern Norway, but not in sufficient quantity to be of commercial importance as a source of uranium or radium. The principal minerals found are fergusonite (4.68 per cent UO_2), euxinite (5.83 per cent UO_2), blomstrandite (4.01–5.35 per cent UO_2), samarskite (9.66 per cent UO_2 and 6.78 per cent UO_3), yttrotantalite (3.85–4.48 per cent UO^2), uraninite of the varieties termed cleveite and bröggerite, uranothorite, orangite, and the secondary minerals uranophane, gummite, etc.

PORTUGAL.[2]

The Portugese uranium deposits are of considerable importance and have been exploited by several French and English companies during the last few years.

The deposits are situated in the granite massif lying in the northern part of Portugal or close to it in the Cambrian schists which it intrudes. The massif covers most of the provinces of Minho, Tras-os-montes, and Beira. The richest deposits are found near the south end of the granite, in the district of Guarda, a part of the province of Beira and are closely connected with tin and tungsten (wolframite) deposits. Most of the deposits lie near the towns of Guarda and

[1] Brögger, W. C., Die Mineralien der südnorwegischen Granitpegmatitgänge: Videnskabs-Selskabets Skrifter, Math.-Naturv Klase, 1906, No. 6, Christiania, 1906; Die Mineralien der Syenitpegmatitgänge der südnorwegischen Augit- und Nephelinsyenite: Zeitschr. Krystallographie und Mineralogie, Leipzig, vol. 16, 1890.

[2] Segaud et Humery, Gisements d'uranium du Portugal: Annales des mines, Paris, 11th ser., vol. 3, 1913, pp. 111–118.

Sabugal, but there are also deposits near Villar Formoso. (See fig. 13.) At Carvalhal Meão autunite and cassiterite occur in the same deposit. The uranium minerals are autunite, torbernite, and some uranocircite (hydrous phosphates of calcium and uranium, copper, and uranium, and barium and uranium, respectively) occurring in pegmatite dikes. The dikes are variable in composition and in places are highly feldpathic, but in other places they are practically pure quartz. They

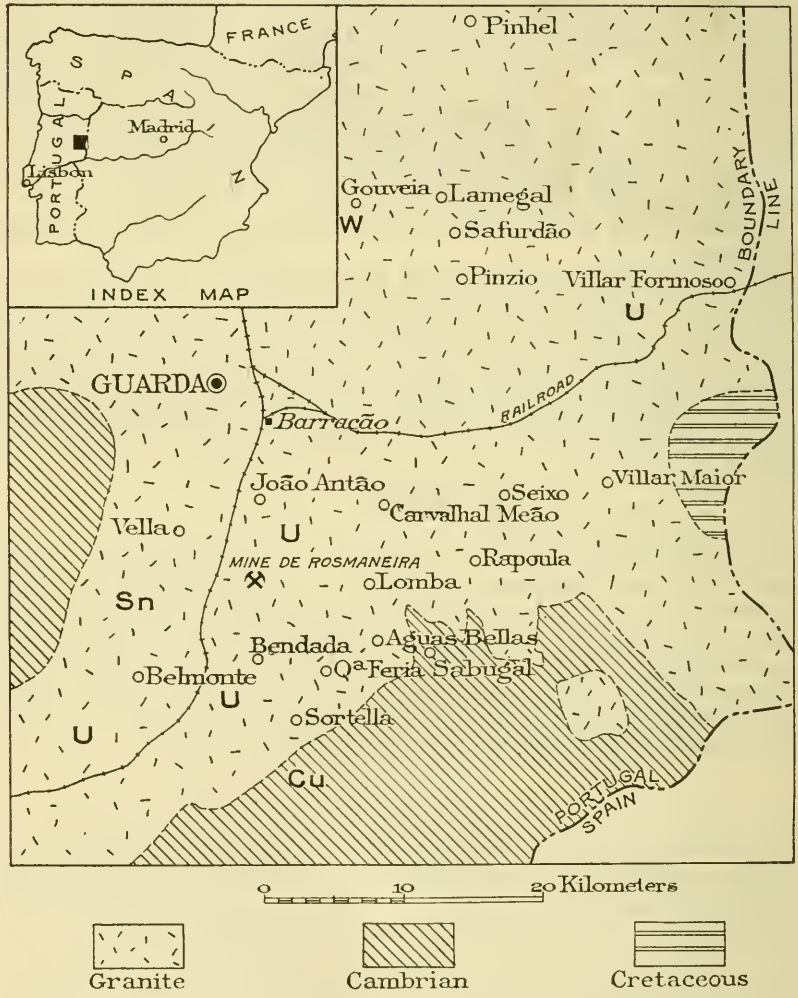

FIGURE 13.—Sketch geologic map showing the location of uranium deposits near Guarda, Portugal. (After Segaud and Humery.)

appear to occur along fault planes, for they are accompanied by salbandes of argillaceous material which also carry uranium.

One dike is 15 kilometers (9.3 miles) in length, the others are shorter. They seem to have no well-recognized general strike, and the dip is variable, but generally steep. In width the dikes vary greatly, an average being perhaps from 20 to 40 inches (0.5 to 1 meter), but a

dike north of Belmonte has a width of 26 feet (8 meters). They pinch and swell in short distances both horizontally and vertically, and the uranium content is likewise variable. On the outcrop a spot in an otherwise almost barren tract "may carry 4 to 5 per cent" uranium trioxide (UO_3?). In working, 2 per cent is considered an excellent tenor, and 1 per cent a good average. The limit below which the deposit becomes unworkable at a profit varies from 0.3 to 0.5 per cent (UO_3?).

Very little work has been done below the water level, but Segaud and Humery believe some other uranium mineral than autunite or torbernite will be found at greater depths and they think they have found an unaltered but unidentified uranium mineral.

Labor is plentiful, cheap, and willing, so that mining can be carried on at low costs.

The principal operating companies are L'Urane (E. Urbain, A. Feige et Cie); Paul Girod; Harding Bros. & Co.; The Guarda Co. (Ltd.); and Henry Burnay et Cie. L'Urane has the most important workings and employs 600 workmen at the Rosmaneira mine.

The uranium mineral can not be easily recognized by the glimmer of the workmen's lamps, so that hand cobbing is out of the question, and the low tenor of the ore makes it almost necessary that all the ore must be chemically treated close to the mine for the recovery of uranium and radium salts. The radium is obtained as a radium-rich barium sulphate.

No details as to the quantity of uranium or radium produced are at hand.

FRANCE.

Up to this time no commercially important deposits of uranium minerals have been discovered in France. Autunite and torbernite and possibly other hydrated uranium minerals are found in Brittany, the Pyrenees, and the Plateau Central, generally in connection with pegmatite.[1]

RUSSIA.

The uranium-bearing minerals and deposits of Russia are not well known, and a commission headed by Dr. Wladimir Vernadsky has been appointed to inquire into the radio active substances of the Empire.

The greatest known deposit of uranium-bearing minerals in the Russian Empire is situated at Tjua-Mujun in the Andijan district, Ferghana Government, central Asiatic Russia. It is about 50 miles from Fedtschenko, the nearest railway station, and lies in the Alai Mountains, north of Turkestan.

The deposit is a large but extremely irregular chimney in Paleozoic limestone.[2] The gangue consists largely of calcite and strontium-bearing barite. The latter is partly in large beautiful crystals. The deposit contains tjuamunite (calcium carnotite, see analysis), turanite (copper vanadate), a little malachite, hematite, and five or six new minerals containing among them uranium, vanadium, bismuth, arsenic, and lead. Vernadsky and Nenadkevich are now working on

[1] Lacroix, A., Minéralogie de la France et de ses colonies, vol. 4, pt. 2, Paris, 1910, pp. 542 et seq.

[2] The information concerning the Tjua-Mujun deposit was received from Dr. Wladimir Vernadsky in personal conversation.

these minerals. Ferganite, described as an ortho-vanadate of uranium, a new mineral, is the most common uranium mineral, but is thought by Nenadkevich [1] to be possibly the same as tjuamunite.

According to local legend, long ago the Chinese first worked the deposit for copper. In recent years it has been worked for vanadium, and the ore was shipped to St. Petersburg, where ferrovanadium was made. But work has ceased, owing to the death of the head of the firm which was conducting operations. Owing to the mode of working, it is believed probable that the radium and much of the uranium may have been lost, but an investigation of the refuse is to be made. Many thousands of tons of ore have been extracted, and the deposit will probably soon be worked again with the intention of saving uranium, radium, and vanadium.

The commission has found uranium-bearing thorianite in Siberian placers and pitchblende in other alluvial deposits. A new uranium-bearing mineral (composition unknown) called mendeleffite has been found near Lake Baikal.

E. de Hautpick [2] cites questionably torbernite or autunite on Wulf Island in the Olonetz Government, northern Russia; samarskite in the Ural Mountains, and a variety, "phishingopite," in Transbaikalia. In this Province, pitchblende is reported near Slyudyanki and torbernite in the Chagir mines of the Bisk district. Mr. de Hautpick found pitchblende containing 76 per cent uranium oxide (U_3O_8) near Kezbek Mountains in the Caucasus.

GERMAN EAST AFRICA.

Uraninite is found embedded in mica in the mica workings operated under the Deutcsh-Ostafrikanischen Gesellschaft in pegmatite on the west slope of Luckwangule, in the Uluguru Mountains, Morogoro district, about 100 miles directly east of Dar-es-Salam on the Indian Ocean. The uraninite when unaltered is very pure and carries 87.7 to 87.9 per cent uranium oxide and is said to be 20 per cent more radioactive than the Joachimsthal pitchblende. Part of the uraninite is altered entirely or in part to rutherfordite, uranium carbonate.[3]

The crystals reach 3.5 by 2.5 by 2 centimeters (1.4 by 1 by 0.8 inches) and are said to be the largest on record,[4] but are apparently not in sufficient quantity to be of commercial value as a source of uranium or radium.

Fergusonite carrying 13.6 per cent uranium oxide (UO_2) is also found in the same locality [5] but apparently in small quantity.

MADAGASCAR.

Autunite, fergusonite (6.15 per cent UO_2, euxenite (16.40 per cent UO_2), blomstrandite (26.60 per cent U_2O_3) and possibly other uranium-bearing minerals are found in pegmatites in several parts of

[1] Nenadkevich, K. A., A new species of mineral: Bull. Acad. Imp. Sci., St. Petersburg, 6 ser., Nov. 1, 1912, p. 946.
[2] Hautpick, E. de, Radioactive minerals in Russia: Min. Jour., London, vol. 92, 1911, pp. 185–186.
[3] Marckwald, W., Ueber Uranerze aus Deutsch-Ostafrika: Centralbl. Mineralogie, Stuttgart, 1906, pp. 761–763.
[4] Brauns, R., Ein grosser Uranpecherzkristall aus Deutsch-Ostafrika: Centralbl. Mineralogie, 1911, pp. 689–690.
[5] Dammer and Tietze, Die nutzbaren Mineralien, vol. 1, 1913, pp. 482–483.

the island,[1] but apparently none are in commercial quantity. Lacroix is quoted as saying[2] that autunite is found on the central plateau in peaty alluvium from which it may be panned.

IMPORTS.

The value of the imports for consumption of uranium oxide and salts, according to statistics furnished by the Division of Statistics, Bureau of Foreign and Domestic Commerce, for the years 1910–1912 was as follows: 1910, $10,176; 1911, $14,106; 1912, $14,357.

No imports of vanadium ores, vanadium salts, or ferrovanadium were separately recorded for the year, although it is known that the American Vanadium Co. imported roasted ore from Peru.

USES.

URANIUM.

The uses of uranium are at present few and limited. According to Merck's (1907) Index uranium and sodium acetate is used in the determination of phosphates; uranylacetate is used in medicine, in photography, in pottery glazes, as an indicator in volumetric determinations, as a detector of morphine, and in the determination of arsenic and phosphoric acids; red uranium oxide (UO_3) is used for painting on porcelain, and as a mordant in calico printing. A number of the salts of uranium are violent poisons.

Uranium nitrate is said to be an excellent catalyser[3] in the synthetic preparation of ammonia.

No use is known for metallic uranium. Attempts have been made to utilize it as a ferro-alloy in making steel, but so far apparently without much success. It is claimed that it gives only such properties to steel as does tungsten, but the cost is very much greater.

RADIUM.

The practical uses of radium are apparently still largely speculative and empirical. It seems to be giving good results in the treatment of at least some forms of cancer, lupus, and skin diseases, and many hospitals desire radium. A letter on the subject by David Salomans[4] quotes hospital authorities on the subject:

Dr. Lazarus-Harlow, director of the cancer research laboratories of the Middlesex Hospital, writes that "the huge majority of our unfortunate patients have to die simply because we have not the radium which would at least relieve their pain, and might in all probability effect a cure in a good proportion of the cases."

Dr. Robert Knox, of the Cancer Hospital, says: "We have been using radium for some time at this hospital and find it most useful in treatment. We have many patients who, with our limited supply of radium, have to wait a considerable time in order to get treatment." They require an additional supply of 800 milligrams, or 12 grains (£12,800), which they could keep continuously in use, but it is quite impossible for the hospital committee to purchase such a quantity.

The Metropolitan Hospital, through its secretary, J. Courtney Buchanan, say that they give treatment to poor patients by large quantities of radium, and have been able to do great good to the poor sufferers.

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[1] Lacroix, A., Minéralogie de la France et de ses colonies, Paris, 1910, vol. 4, pt. 2, pp. 547–548, 609, 610–611, 612–613.

[2] Min. Jour., London, May 4, 1912, p. 430.

[3] Catalysis and catalysers: Min. Jour., London, vol. 102, 1913, pp. 722–723, quotation from Echo des Mines, Paris.

[4] Quotation from The Times, London, in Min. Jour., London, vol. 100, 1913, p. 245.

Uric acid is broken up by radium emanation [1], and this gives a basis for treatment of rheumatism through baths in water which contains radium emanation, and also through more direct application, and it now seems to be generally considered that much of the effectiveness of many of the famous baths for rheumatism and kindred ailments may be due to radioactivity. This is probably not wholly proved. A great mass of literature has already sprung up on radium-therapy, and much experimenting is in progress.

Radioactive substances are claimed to affect plant growth advantageously, but no practical use is known to have been made of this property.

Radium has caused an immense amount of scientific research and the changing of many ideas upon the composition of matter.

VANADIUM.

The chief use of vanadium is in the manufacture of special steels. Probably much the larger part of the "high-speed" tool steels now on the market contains a small percentage (less than 1 per cent) of vanadium. It is also used in making cast steels where especial toughness is desired, and is much used in locomotive frames and tires and in automobile construction. In smaller quantities it finds a number of uses. Dr. Fritz Ephraim [2] quotes the following uses:

With aniline as a brick dye, as V_2O_5, it has been used in place of platinum in the contact process for the manufacture of sulphuric acid (though it is said to be less effective than platinum); as a photographic developer. In medicine salts with potassium chlorate have been used under the name of "vanadin." Vanadium salts are said to be favorable to the growth of plants; vanadyl phosphate acts physiologically like potassium permanganate; from vanadates and tannic acid a waterproof black ink is made; vanadium salts are used in coloring glass; vanadic acid is used to determine hydroxylamin and hydrazin in the presence of ammonia.

Metavanadic acid has been used to some extent as a substitute for gold bronze in paint. Vanadium chloride is used as a mordant in printing fabrics, and the trioxide as a mordant in dyeing.[3] Vanadic anhydride (V_2O_5) has been used in the reduction of various organic compounds in an acid bath, e. g., the manufacture of quinone from aniline, etc. It also greatly accelerates certain oxidation processes, such as the action of nitric acid on sugar, the oxidation of alcohol by atmospheric oxygen." [4]

PRICES.

There was no standard of prices for carnotite ores during the year, and, under the circumstances, little chance of standardization, a condition which was very unsatisfactory for the miners and probably not very much better for the buyers. Much of the ore was shipped to New York for sampling and analysis, and the ore had to be shipped on its general appearance and the results awaited. It thus happened that some shipments did not pay for the freight and expense of mining. When shipments of ore brought less than was expected, miners were inclined to think that there was some combination of buyers to prevent the payment of fair prices. On the other hand there is known to have been more or less jealous competition among some buyers, and certain foreign firms are said to have refused to buy carnotite ores on account of the low percentages of uranium and

[1] Mezeruickyi, quoted in Medical News, Jour. Am. Med. Assoc., Chicago, vol. 49, 1912, p. 2170.
[2] Ephraim, Fritz, Das Vanadin und seine Verbindungen: Sammlung chemischer und chemisch-technischer Vorträge, vol. 9, pts. 3–5, Stuttgart, 1904, pp. 83–84.
[3] Merck's (1907) Index.
[4] Roscoe and Schorlemmer, Treatise on chemistry, 1907, vol. 2, The Metals, p. 898.

vanadium contained, and the large quantity of worthless gangue which must be handled and treated. Prices varied much, but 25 to 30 cents a pound for the contained vanadium oxide (V_2O_5) and $1.30 to $1.50 a pound for the contained uranium oxide (U_3O_8) where it exceeds 2½ per cent, seem to have been the rule. The prices were considered too low by some producers, and their ore was stored to await a rise.

The price of metallic vanadium was much below former years, and from $4 or $5 it fell to $2.50 or $2 a pound for the contained vanadium in ferrovanadium, undoubtedly owing to the competition between American firms.

FIELD TESTS FOR URANIUM AND VANADIUM.

Uranium.—No simple chemical tests for uranium that are suitable for ordinary field use are known. If, however, uranium is present in anything like commercial quantity its presence may be shown by the radioactivity of its decomposition products thus: Lay the suspected mineral upon a plate holder containing a sensitive photographic plate, and let it lie for 12 hours to a week. If uranium is present in any considerable quantity the plate will be light-struck. Plate II, *B*, represents a plate treated in such a way for 24 hours with a piece of pitchblende from the Calhoun mine, Gilpin County, Colo. As soon as the pitchblende was removed and the exposed plate was taken out a fresh plate was put in the holder for 48 hours and then developed, but it showed no sign of fog. This seems to show that plate holders can be used for such tests without danger of fogging, by induced radioactivity, plates put in the holder afterwards.

Minerals containing thorium have the same effect upon a photographic plate, and if there is reason for suspecting the presence of thorium and the circumstances warrant, then the minerals should be submitted to careful chemical examination.

Vanadium.—Most of the vanadium minerals, especially those of the oxidized zone are readily soluble in mineral acids. Hydrochloric is the most convenient acid to use. If concentrated hydrochloric acid (HCl) is put upon carnotite, vanadinite, the descloizites, and some other vanadium minerals, it immediately gives a rich red-brown colored solution. If water is added the color changes to green or disappears. If the dilution is not too great the brown color reappears upon the addition of hydrogen peroxide (H_2O_2). If metallic zinc be added the green color will again appear and may gradually fade until the solution becomes colorless.

Calcium vanadate and a few other oxidized minerals do not show the brown-red color at once, but must be treated with the acid for a longer time. Heating will hasten the reaction.

If dilute acid is used the solution is ordinarily greenish, yellowish (from uranium), or colorless. Upon the addition of hydrogen peroxide the reddish-brown color is given, and added zinc will again bring the green color or decolorize the solution. Vanadium-bearing silicates, such as roscoelite, may be treated with dilute acid and either be allowed to stand for some time or be boiled, after which good reactions may be obtained.

With carnotite, vanadinite, the descloizites, and some other minerals, it is only necessary to place a drop of concentrated hydrochloric

acid upon the mineral to get the rich red-brown color almost immediately. The addition of 2 or 3 drops of water makes the color change to light green or disappear.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON RARE METALS.

The following articles on rare metals have been published by the United States Geological Survey. Those that are out of stock for free distribution can be obtained from the Superintendent of Documents, Washington, D. C., for the price indicated.

TUNGSTEN.

Bancroft, Howland, Notes on tungsten deposits near Deer Park, Wash.: Bull 430, 1910, pp. 214–216.

Brooks, A. H., Geologic features of Alaskan metalliferous lodes: Bull. 480, 1911, pp. 88–90.

Hess, F. L., Note on a tungsten-bearing vein near Raymond, Cal.: Bull 340, 1908, p. 271. 30 cents.

——— Tin, tungsten, and tantalum deposits of South Dakota: Bull 380, 1909, pp. 131–163. 40 cents.

——— Note on a wolframite deposit in the Whetstone Mountains, Arizona: Bull. 380, 1909, pp. 164–165. 40 cents.

——— Tungsten: Mineral Resources U. S. for 1908, pt. 1, 1909, pp. 721–731. 60 cents.

Hill, J. M., Note on the occurrence of tungsten minerals near Calabasas, Ariz.: Bull. 430, 1910, pp. 164–166.

Hobbs, W. H., The old tungsten mine at Trumbull, Conn.: Twenty-second Ann. Rept., pt. 2, 1901, pp. 13–22.

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——— Tungsten deposits in the Snake Range, White Pine County, eastern Nevada: Bull. 340, 1908, pp. 263–270. 30 cents.

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——— Notes on the vanadium deposits near Placerville, Colo.: Bull. 530, pp. 142–155.

——— Carnotite near Green River, Utah: Bull. 530, 1911, pp. 161–164.

——— Vanadium in the Sierra de los Caballos, New Mexico: Bull. 530, 1911, pp. 157–160.

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Watson, T. L., and Taber, Stephen, The Virginia rutile deposits: Bull. 430, 1910, pp. 200–213.

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TANTALUM.

HESS, F. L., Tin, tungsten, and tantalum deposits of South Dakota: Bull. 380, 1909, pp. 131–163. 40 cents.
——— Mineral Resources U. S. for 1908, pt. 1, 1909, pp. 748–749. 60 cents.

ANTIMONY.

By Frank L. Hess.

PRODUCTION.

No antimony has been produced in the United States from domestic ore and no domestic antimony ores have been mined and marketed since 1907, so far as can be learned by the United States Geological Survey, though a little metallic antimony was at one time saved as a by-product in the electrolytic refining of lead ore. None was reported, however, as saved during 1912 or 1911.

The American deposits of antimony ore are in general too small, too far from markets, lack cheap transportation, or are in places where conditions make working too difficult and expensive for them to compete with foreign deposits. A considerable quantity of antimony is saved, however, each year in the form of antimonial lead, which is obtained at the smelters of precious metals in the course of their operations, and large quantities of antimonial alloys are recovered from secondary sources, such as scrap-bearing and type metals, solder, and antimonial lead drosses.

The following table shows the production of antimony in the United States since 1903:

Production of antimony in the United States, 1903–1912, in short tons.

Year.	Contained in antimonial lead of domestic origin.		Contained in antimonial lead of foreign origin, but smelted in the United States.		Antimony produced from domestic ore.		Recovered from old alloys, scrap, dross, etc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	2,558	$445,092	.....	.....	570	$103,341	.....	.....
1904	2,571	443,598	.....	.....	[a] 486	61,926	.....	.....
1905	2,747	588,354	.....	.....	493	117,433	.....	.....
1906	1,362	[b] 544,800	.....	.....	[c] 404	58,149	.....	.....
1907	1,561	[d] 508,886	.....	.....	[c] 351	77,300	.....	.....
1908	2,246	[e] 359,360	.....	.....	(f)	(f)	.....	.....
1909	1,617	[g] 252,252	743	[g] $115,908	(f)	(f)	1,556	[g] $242,736
1910	1,598	[h] 263,431	631	[h] 103,906	.....	.....	[k] 2,779	[h] 457,979
1911	1,543	[i] 264,780	711	[i] 122,006	.....	.....	[k] 2,369	[i] 406,520
1912	1,224	[j] 209,059	725	[j] 123,830	.....	.....	[k] 2,506	[j] 428,025

[a] Estimated from the average content of the ore.
[b] Estimated from the prices current for the year.
[c] Figured as 60 per cent of domestic ores only; direct figures from the smelters could not be obtained.
[d] Estimated, using 16.3 cents as the average price per pound.
[e] Estimated, using 8 cents as the average price per pound.
[f] None produced from domestic ore. Figures not collected for foreign ores.
[g] Estimated, using 7.8 cents as the average price per pound.
[h] Estimated, using 8.24 cents as the average price per pound.
[i] Estimated, using 8.58 cents as the average price per pound.
[j] Estimated, using 8.54 cents as the average price per pound.
[k] Figures collected by J. P. Dunlop, United States Geological Survey. In 1910 a total of 9 tons, in 1911 a total of 10 tons, and in 1912 a total of 13 tons was recovered as antimony, the remainder as alloy.

The total of 1,949 tons of antimony produced from both domestic and foreign ores in 1912 was contained in 8,549 tons of antimonial lead, of which it formed 22.8 per cent. The percentage of antimony n the antimonial lead is higher than that reported for 1911, in which year the percentage was 16.01.

The values given in the table are arbitrary and must not be taken as exact. Antimonial lead generally contains impurities, such as arsenic, iron, and copper, and it is impracticable to obtain pure antimony and pure lead from the alloy at a cost low enough to afford a profit, though the alloy sells at a lower price than the metals singly. A rule by which antimonial lead is sometimes sold is to add the price of the contained antimony, supposing it to be equal to Cookson's, to that of the contained lead and then to subtract $5 per ton. For lack of a better basis, for the year 1912 the value of the antimony content has been figured at 8.54 cents per pound, the average price of Cookson's during the year.

Although the production of antimony in antimonial lead is indirect, it is quite as important as the production of an equivalent quantity of segregated antimony, for there is a demand for antimonial lead which would have to be met by alloying the two metals were they not thus produced, and in fact most of the antimony imported both as metal and as ore is thus used.

IMPORTS.

A large quantity of antimonial lead is imported into the United States under the name of type metal, for which it is largely used. The following table showing imports of type metal for consumption is taken from the records of the Bureau of Foreign and Domestic Commerce:

Type metal imported and entered for consumption, 1903–1912, in short tons.

Year.	Type metal.		Antimony content.	
	Quantity.	Value.	Quantity.	Per-centage.
1903	3,302	$208,728	.....	.....
1904	4,072	221,127	630	15.5
1905	6,966	456,155	1,228	17.6
1906	9,801	900,608	1,853	18.9
1907	7,416	932,027	1,369	18.4
1908	2,055	156,847	422	20.5
1909	6,997	532,108	1,327	19.0
1910	6,697	485,493	1,109	15.1
1911	4,195	310,658	727	17.3
1912	291	18,668	52	18.0

Prior to 1904 the composition of type metal was not given in the customs returns. The lead content only is given, and it is assumed that the remainder is practically all antimony. This assumption is, however, wholly arbitrary, for imported type metal contains as much as 2 per cent of impurities, such as iron, arsenic, and copper, but there is no way of estimating its impurities. The antimony content is therefore probably too large by some quantity less than or approximately equal to 2 per cent of the total quantity of type metal, and the correct percentage is correspondingly lower.

Old type weighing 164 tons, valued at $20,469, and new type weighing 23 tons, valued at $8,691, were also imported in 1912.

In the following table the imports of antimony and antimony ore for consumption, as obtained from the Division of Statistics, Bureau of Foreign and Domestic Commerce, are given since 1902, in order to show the great variation in both quantity and value of the imports from year to year. The imports of salts of antimony are given from 1903 to 1910, the earliest and latest years for which the Survey has obtained statistics.

Antimony, antimony ore, and salts of antimony imported and entered for consumption in the United States, 1902–1912, in pounds.

Year.	Metal and regulus.		Crude antimony and ore.		Oxide and salts of antimony.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1902	5,388,739	$333,601	3,129,069	$62,968	.....	.....	$396,569
1903	4,694,309	260,144	2,714,617	54,316	916,468	$66,469	380,929
1904	4,268,045	248,726	2,488,518	50,414	981,026	70,668	369,808
1905	4,941,247	431,228	1,970,788	53,026	1,010,228	80,130	564,384
1906	10,305,734	1,391,289	1,972,658	125,841	764,070	99,251	1,616,279
1907	9,600,901	1,407,861	2,771,387	180,903	682,192	98,038	1,686,802
1908	8,089,915	771,206	3,287,218	106,930	623,125	65,898	944,034
1909	9,557,956	620,117	3,453,542	94,249	955,360	60,353	774,719
1910	7,955,945	492,570	1,346,962	47,185	326,136	14,201	553,956
1911	8,486,137	470,552	1,641,467	60,459	[a]1,003,647	54,426	585,437
1912	13,936,873	808,473	1,562,066	51,444	[a]1,759,908	81,077	940,994

[a] Oxide only. No figures showing the imports of antimony salts are now given in the customs returns.

PRICES.

The price of antimony has not fluctuated greatly during the last five years, the extreme monthly averages as given by the American Metal Market and Daily Iron and Steel Report [1] being 7.22 and 10.31 cents a pound for Cookson's antimony, and both prices prevailed in 1912, the lower being that for February and the higher that for November. Hallett's generally sells for about a cent a pound less than Cookson's, and other brands are lower according to quality and reputation, which seems to be fully as important. The average price of Cookson's for the year was 8.54 cents a pound.

SECONDARY ANTIMONY.

Concerning the production of secondary antimony, J. P. Dunlop, of this Survey, furnishes the following note:

The production of secondary antimony, of which all but 13 tons was recovered in alloys, increased from 2,369 short tons in 1911 to 2,506 tons in 1912. The production in 1912 includes 135 tons of contained antimony recovered from scrap antimonial lead by regular smelters. The principal refined or remelted materials that contained antimony as an alloy were hard lead drosses, babbitt, solder, pewter, and type metal. The recovery of antimony from secondary sources amounted to 29 per cent of the 1912 imports of antimony as metal, in ore, and as oxide, amounting to 8,685 tons. The secondary recoveries of antimony were double those of the antimony content of antimonial lead ores of domestic origin smelted in 1912.

[1] Metal Statistics, 1913, p. 243.

BISMUTH.

By Frank L. Hess.

No production of bismuth ore in the United States during 1912 was reported to the United States Geological Survey, but one lot which was taken from the Highland Mary mine at Leadville, Colo., in 1911 was sold in 1912. The ore was rich in gold and carried 15.47 per cent of bismuth in the form of carbonate.

The American Smelting & Refining Co. and the United States Metals Refining Co. both produced a considerable quantity of bismuth as a by-product during the year, and it seems entirely possible that in time enough bismuth may be produced from the various smelters to supply the domestic market. Heretofore large buyers have claimed that they could not safely buy of American producers of bismuth, for should they do so and should the American producers be unable to continue supplies the agents of the foreign sellers would thereafter refuse to sell bismuth to them, and the lack of a constant supply has always been a possibility to be feared.

Bismuth occurs generally in small quantity, but in some lots in considerable percentages with gold and silver ores at various places in Colorado and other Western States, and with lead ores in Utah. When these ores are smelted the bismuth may be collected in the lead bullion. From this bullion the bismuth is obtained in the anode muds in electrolytic refining.

Bismuth also occurs with the copper ores of the Butte region and, as has been frequently noted, in the aggregate a large quantity passes out of the smelter stacks with the fumes. Some remains in the copper bullion and is found in the anode muds of the electrolytic refineries.

According to figures published by the Division of Statistics, Bureau of Foreign and Domestic Commerce, 182,840 pounds of metallic bismuth, valued at $316,440, were imported for consumption during the year 1912.

Imports for consumption of metallic bismuth into the United States, 1904–1912, inclusive, in pounds.

Year.	Quantity.	Value.
1904	185,905	$339,058
1905	148,589	318,007
1906	254,733	318,452
1907	259,881	325,015
1908	164,793	257,397
1909	183,413	286,516
1910	198,174	332,668
1911	172,093	311,771
1912	182,840	316,440

The price of bismuth in 1912, as in former years, appeared to be governed closely by foreign firms, and was quoted by the technical press at $1.80 to $2 a pound until September, during which month the quotations were raised to $2 to $2.25 a pound.

Metallic bismuth is employed in making low-fusing alloys or cliché metals which are used in automatic fire sprinklers, fuses for electric wiring, and solders. Some of the salts have a smooth, unctuous feel, and are used in face and toilet powders and in medicinal preparations. It is also employed to a small extent in making optical glasses.

SELENIUM.

By Frank L. Hess.

Only one smelting company reported the production of a considerable quantity of selenium in 1912, though one other company made a few pounds, and on this account the quantity may not be given. The value was estimated at $2.50 a pound.

No selenium is known to have been imported.

As heretofore, the selenium produced was obtained from the anode muds left in the electrolytic refining of copper. Although selenium minerals are rarely or never found in copper deposits, nearly all copper bullion made from sulphide ores carries a little of the element. At Ducktown, Tenn., as at most places, selenium has not been detected in the copper ores, but some of the sulphuric acid made from the sulphurous gases is given a pink or reddish tint by selenium.

Selenium is used principally in making red glass, enamels, and glazes. Small quantities are also used in photometers and electric apparatus.

CHROMIC IRON ORE.

By J. S. Diller.

PRODUCTION.

The chromic iron ore produced and sold in the United States was nearly 70 per cent greater in 1912 than in 1911, and if the production not sold is taken into account the increase was still greater, for less than 25 per cent of the total quantity mined in 1912 was actually sold. The total output marketed in 1912 was 201 long tons, valued at $2,753, as compared with 120 tons, valued at $1,629, in 1911.

California is the only producing State, and the output comes from three separate deposits. The mine near Dunsmuir, Siskiyou County, increased its production, but the mines in Shasta and Glenn Counties were not operated.

Two new mines were opened, one near Livermore, in Alameda County, and the other near Piedra, in Fresno County. Both these mines are operated by the same company.

A small quantity of chromite is said to have been taken from the ground in Wyoming, but none was sold.

The quantity and value of chromic iron ore produced in the United States since 1880 is given in the following table. All the ore came from California except a small part from Wyoming in 1908 and 1909.

Production of chromite in the United States, 1880–1912, in long tons.

Year.	Quantity.	Value.	Price per ton.	Year.	Quantity.	Value.	Price per ton.
1880	2,288	$27,808	$12.15	1897	.....	.....	.....
1881	2,000	30,000	15.00	1898	.....	.....	.....
1882	2,500	50,000	20.00	1899	.....	.....	.....
1883	3,000	60,000	20.00	1900	140	$1,400	$10.00
1884	2,000	35,000	17.50	1901	368	5,790	15.73
1885	2,700	40,000	14.81	1902	315	4,567	14.50
1886	2,000	30,000	15.00	1903	150	2,250	15.00
1887	3,000	40,000	13.33	1904	123	1,845	15.00
1888	1,500	20,000	13.33	1905	22	375	17.05
1889	2,000	30,000	15.00	1906	107	1,800	16.82
1890	3,599	53,985	15.00	1907	290	5,640	19.45
1891	1,372	20,580	15.00	1908	359	7,230	20.14
1892	1,500	25,000	16.67	1909	598	8,300	13.88
1893	1,450	21,750	15.00	1910	205	2,729	13.31
1894	3,680	53,231	14.46	1911	120	1,629	13.58
1895	1,740	16,795	9.65	1912	201	2,753	13.70
1896	786	6,667	8.48				

World's production.—For the purpose of showing the relation of the production of chromite in the United States to that of other countries the following table of world's production is introduced:

World's production of chromic iron ore, 1906–1911, in long tons.

Country.	[a] 1906	[a] 1907	[a] 1908	[a] 1909	[a] 1910	[b] 1911
United States	107	290	359	598	205	120
Bosnia and Herzegovina	315	305	492	327	315	246
Canada	8,067	6,425	6,451	2,205	267	140
Greece	11,348	11,545	4,281	9,448	9,311	(c)
India	4,375	7,274	4,745	9,250	1,737	(c)
New Caledonia	82,910	3,739	15,550	39,368	39,368	81,475
New South Wales	15	30				(c)
Rhodesia	3,256	8,017	11,927	22,875	39,304	46,737
Russia	18,713	25,940	10,777	(c)	(c)	(c)
Sweden					31	(c)
Turkey	[d] 23,404	[d] 21,111	[d] 3,783	28,404	11,363	(c)

[a] Statistics taken from Mines and Quarries: General Report with Statistics, pt. 4, London.
[b] Statistics taken from various sources.
[c] Statistics not available.
[d] Export figures.

PRICES.

The importation of chromic iron ore duty free in large quantities from many foreign localities is a prime factor in the control of the American market. The ore is sold on the basis of 50 per cent chromic oxide and in 1912, as in 1911, was quoted [1] for carload lots ex-ship in New York at $14 to $16 per long ton. Special furnace chrome, which is practically pulverized ore and which is used in laying chrome brick, is quoted at $30 per ton net.

The price of California ore was $13.57½ per long ton in 1911. In 1912 it averaged $12.23 per long ton, although some of the richer ore sold for $17 per ton. The ore was used chiefly on the Pacific coast. The long railroad haul and the cheaply imported foreign ores make it difficult for the California ore to enter the eastern market.

Imported bichromate of potash was quoted in New York, January, 1912, at 7⅜ to 7¾ cents per pound, but in February it fell to 6⅞ and 7 cents and remained so. American manufacturers quote it in single casks weighing from 700 to 800 pounds each at 7 cents per pound; they quote bichromate of soda in casks at 5 cents per pound—f. o. b. at seller's works in both cases.

Chromium has been of commercial importance for only about 15 years. Ingot chromium is reported as selling at about 80 cents per pound, although electrolytic chromium is quoted at $2.25 per pound, and 95 per cent chromium in powdered form at $1.50 per pound. In its alloys with iron, which are made by direct reduction with carbon, it is sold for 29 cents per pound.

Chrome brick have been quoted [1] during the greater part of 1912, as in 1911, at $175 per thousand f. o. b. in Pittsburgh, but recently it has been reported that chrome brick is selling at $157 f. o. b. in Pittsburgh and at $145 per thousand f. o. b. in Chester, Pa. The difference in price is due to freight.

[1] Eng. and Min. Jour.

IMPORTS.

Within the last eight years considerable quantities of chromite have been imported from New Caledonia, Greece, Canada, Great Britain, Asiatic Turkey, Belgium, Germany, France, Cuba, Australia, Tasmania, New Zealand, and South Africa.

In 1912 the imports of chromite amounted to 53,929 long tons valued at $499,818, an increase of 16,389 long tons in quantity and of $91,860 in value as compared with the imports in 1911. The imports of chromates, bichromates, and chromic acid also increased in 1912.

Chromate and bichromate of potash, chromic acid, and chrome ore imported and entered for consumption in the United States, 1908 to 1912, inclusive.

Year.	Chromate and bichromate of potash.		Chromic acid.		Chrome ore.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Long tons.*		
1908	216,081	$15,453	3,805	$708	27,876	$345,960	$362,121
1909	537,017	28,837	7,559	1,412	39,624	460,758	491,007
1910	406,790	19,569	9,850	1,635	38,579	415,768	436,972
1911	22,408	2,159	6,789	1,349	37,540	407,958	411,466
1912	32,913	3,085	8,728	1,376	53,929	499,818	504,279

The imported chromite came chiefly from Rhodesia in South Africa and New Caledonia; a considerable quantity came from Greece.

For the fiscal year ending June 30, 1911, it is reported [1] that 4,500 long tons of chromite were imported from Greece and the same quantity from Turkey in Asia. The sum of the imports for these two countries exceeded slightly the quantity imported from New Caledonia, but was a little less than half of that from Rhodesia, which is the chief source of our imported chromite.

The accompanying table shows the importations during 1911 and 1912:

Imports of chrome or chromium and ferrochrome in 1911 and 1912, in long tons.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
Valued at $200 and less per ton	240.03	$20,173	436	$47,179
Valued at more than $200 per ton	13.50	7,729	38	30,409

[1] Commerce and Navigation, 1911, Dept. Commerce and Labor, p. 251.

CHROMIUM ORE.

CHROMITE.

The metallic element chromium occurs in nearly a dozen different minerals, but by far the most important mineral commercially that contains chromium and that is mined to any considerable extent as a source of chromium and its alloys and compounds is chromite (chromic iron ore), represented by the general formula $(Fe,Mg)O(Cr,Al,Fe)_2O_3$.

The theoretical composition of chromite is $FeO.Cr_2O_3$, in the proportions 32 per cent ferrous oxide (FeO) and 68 per cent chromic oxide (Cr_2O_3); but in many ores the ferrous oxide is partly replaced by magnesia (MgO) up to 30 per cent, and the chromic oxide by alumina (Al_2O_3) up to 20 per cent. The percentage of chromic oxide may thus be as low as 10 per cent, but generally ranges between 40 and 60 per cent. The ore is usually marketed on a basis of 50 per cent chromic oxide. The ferrous oxide content varies from 10 per cent to 50 per cent.

MODE OF OCCURRENCE OF CHROMITE.

Although found in some magnesian schists and dolomites, chromite is practically limited in its occurrence of economic importance to the basic igneous rocks amphibolite, pyroxenite, and peridotite, all of which are heavy rocks and alter more or less completely to serpentine or talc. Chromite is a primary mineral; it was one of the first to crystallize out of the molten rock magma as it cooled, forming bodies ranging from small, irregular grains to masses hundreds of feet in extent. It is usually most abundant near the borders of the basic intrusive mass, a fact which should be borne in mind when prospecting for deposits of chrome ore.

Amphibolite is composed chiefly of hornblende and pyroxenite is composed chiefly of pyroxene; both rocks are for the most part completely crystalline and distinctly granular and range in color from dark to pale green. Peridotite is composed chiefly of olivine and where purest has a yellowish-green color. It readily alters to serpentine, which is brighter green in color and more easily recognized as serpentine than that derived from amphibolite or pyroxenite. In the United States the workable bodies of chromic iron ore appear to be associated most commonly with serpentine derived from peridotite.

DISTRIBUTION OF CHROMITE IN THE UNITED STATES.

Chromite is widely distributed in the United States, particularly in the serpentines of the Atlantic coast and the Rocky Mountains, as well as of the Pacific coast.[1]

Chromite was first discovered in America in 1827 at Bare Hills, about 16 miles northwest of Baltimore, Md., where the industry of manufacturing chrome pigments was soon begun. Numerous bodies of chromite were found in serpentine extending from Cecil County, Md., into Lancaster and Delaware counties, Pa. The largest

[1] The most complete account yet published concerning American localities of chromite from a commercial point of view is that by E. C. Harder in his report on chromic iron ore in Mineral Resources of the United States for 1908.

body near the Pennsylvania-Maryland line was opened in 1828, and, except from 1868 to 1873, was operated until 1881, when both the California and the Turkish chromite came into prominence.

In the Atlantic States chromite has been found also in Massachusetts and North Carolina. The only considerable deposit yet noted in the Rocky Mountains is in the western part of Converse County, Wyo. Though of low grade and far from the railroad, it may become of economic importance.

On the Pacific coast, where basic eruptive rocks, including serpentine, are abundant, numerous bodies of chromite have been reported in the serpentine of the Sierra Nevada, the Klamath Mountains, and the Coast Ranges, and at present this field is the source of the entire production of the United States, the mines being in Siskiyou, Alameda, and Fresno counties.

FOREIGN SOURCES OF CHROMITE.

Although commercial bodies of chromite have been found at many localities in several countries, the composition of the ore and the distance of the deposit from the market are so important that comparatively few deposits are worked at present.[1]

The most important production of chromite in 1912 was in New Caledonia, an insular French possession east of Australia; Rhodesia, in British South Africa; and Greece. In 1911 chromic iron ore was brought to the United States also from Canada, Japan, and Turkey in Asia, but the quantity was small compared with that imported from some other countries.

New Caledonia.—New Caledonia produced more than 80,688 long tons of chromite in 1911. In the southern part of the island the ore occurs in two forms—(1) rich, soft, easily broken masses in ferruginous clay, and (2) veins and irregular masses in serpentine. The more friable ore is in greater demand and is more easily separated from the associated rock.

The largest deposits are in the northern part of the island around the Tiebaghi mine, which yields monthly about 4,000 tons of ore, the richest carrying as much as 67 per cent of chromic oxide. The only ore worked below the surface is in the Lucky Hit mine south of Noumea. The ore contains 30 to 40 per cent of chromic oxide and is concentrated mechanically to marketable grade.

The shipping point for New Caledonia ore is Noumea. In 1909 the price of 50 per cent ore f. o. b. at Noumea averaged £1 14s. 6d. ($8.30) per ton and at the mine £1 2s. ($5.37) per ton.

Rhodesia.—In South Africa there are deposits of chromite in Transvaal, Natal, and Rhodesia, but the last is now by far the most important.

The principal point of production in Rhodesia is Selukwe, and the output goes mainly by a comparatively easy railroad haul to Beira, on the Indian Ocean. During 1910 the shipments amounted to 4,400 long tons, in 1911 to 52,363 long tons, and during the first 11 months of 1912 to 54,052 long tons. More than a third of the output in 1911 came to the United States. The ore is easily mined at low

[1] A good account of the distribution and utilization of chromium ores is published in Bull. Imp. Inst., vol. 8, Nos. 3 and 4, 1910.

cost and, being near the railroad, is easily marketed. The ore body is large and is associated with serpentine.

Chromite is known in other parts of southern Rhodesia—for example, at Victoria, Makwiro, and Lomagundi—and it is not unlikely that these localities contain large bodies of ores. The chromic-oxide content varies and in some places, as at Makwiro, is low. The deposits appear to be connected with the great intrusion of picrite which runs north and south through southern Rhodesia from Zambesi River almost to the Limpopo and is marginally altered to serpentine in several places.

The following analysis[1] shows the composition of one grade of Rhodesian ore included under the prices quoted.

Composition of Rhodesian chromic iron ore.

	Per cent.
Sesquioxide of chromium	51.84
Protoxide of iron	11.21
Peroxide of iron	.68
Magnesia	16.88
Alumina	14.92
Silica	3.48
Lime	
Oxide of manganese	.60
Sulphuric acid	
Phosphoric acid	.02
Combined water, etc	.55
	100.18
Moisture in sample as received	.09

Greece and Turkey in Asia.—In both Greece and Turkey in Asia chromite occurs at many localities, but it is not mined so extensively as before it had to compete with the production from New Caledonia and Rhodesia. It is said that for some purposes, especially refractory uses, the Grecian ore excels.

Canada.—Some years ago, as is shown in the table of world's production, Canada was an important producer of chromium and much of its output was shipped to the United States, but the output has now declined to insignificance.

Charles Camsell[2] calls attention to masses of chromite containing diamonds in the Tulameen district of British Columbia. The chromite is in serpentine derived from peridotite. The diamonds, though of good quality, are small, difficult to extract, and probably of no economic value.

USES OF CHROMIUM.

The uses of chromium depend first of all, as its name implies, on the strong colors of its compounds, and also on its high resistance to heat, its chemical neutrality, and its capacity to form alloys.

Both the chemical and the metallurgical uses of chromium were considered fully in the Survey report for 1908 by E. C. Harder and need but little attention at this time. More chromium ore is now used in the United States for chemical than for metallurgical purposes; it is consumed in the manufacture of pigments, dyes, and various chemical compounds, and also in tanning (tawing) light leather,

[1] Furnished by E. J. Lavino & Co., Bullitt Building, Philadelphia.
[2] Econ. Geology, vol. 6, September, 1911, p. 605.

rendering it tough and resistant to moisture. Most chromium pigments are very permanent. Among them are chrome green, chrome yellow, and chrome orange, which are used also as dyes. Chromates and bichromates are used as mordants in dyeing and printing cotton, linen, and wool. As oxidizing agents they form chromic oxide, which is fixed on the fiber and prepares it to hold the dye.

Chromium is used metallurgically in making chromium alloys and furnace linings, the latter either in the form of chrome bricks or of irregular coarse and fine fragments of chromite hammered into place without the use of cementing material.

The consumption of chrome ore by the steel works as a refractory material for lining and repairing open-hearth furnaces has not increased in the Atlantic States to any appreciable extent within the last few years, notwithstanding the fact that the capacity of steel production is increasing. Although this may indicate a definite trend, it is a common opinion that for refractory purposes chromite will be more extensively used when its value becomes better known. In furnace linings chromite has the advantages over magnesite of resisting corrosion (being neutral), of retaining a fair degree of hardness at high temperatures so as to resist abrasion, of withstanding sudden temperature changes, and of requiring less delicate handling. On these accounts, it is said, furnace operators in the West are taking considerable interest in chromite as a substitute for the more expensive magnesite and the silica-alumina materials.

The use of chromium in making alloys, such as ferrochromium and ternary and quaternary chromium steels, is extensive. Chromium gives to steel a marked degree of hardness, and if added in the proper proportion it does not produce brittleness. The properties of chromium steel vary with the quantity of chromium and of carbon it contains. The presence of excessive carbon tends to produce brittleness, on account of the development of double carbides of chromium and iron. Chromium steel alone or alloyed with tungsten or molybdenum is used for making high-speed tools. It is also used in the manufacture of files, ball bearings, armor plates, and armor-piercing projectiles, for which it is generally alloyed with nickel, vanadium, or manganese. The Government, as a rule, does not attempt to control the composition or treatment of the steel used for armor and projectiles, but bases its acceptance or rejection of material on the results of the ballistic test. The percentage of chrome is, however, generally thought to range from 1.25 to 2.25 per cent.

With the increased use of ferrochrome for the manufacture of chrome vanadium steels, the consumption of chrome ore by the domestic ferrochrome makers is steadily increasing from year to year, and at some future date, it is believed, the tonnage used in the metallurgical industry for refractory purposes and for making ferrochrome will equal and may exceed the present tonnage of ore consumed for chemical purposes. An authority[1] on this subject roughly estimates that the present consumption of chrome ore is about 25,000 tons a year in the chemical industry and approximately 15,000 to 20,000 tons a year in the metallurgical industry.

[1] E. J. Lavino & Co., letter Feb. 25, 1913.

NOTES ON THE CHROMIC IRON ORE INDUSTRY.

The United States has never been a large producer of chromic iron ore. Its maximum annual production in 1894 was nearly 4,000 tons. Since then both the annual production and the price have fluctuated from various causes, among which the moderate demand, the pockety character and wide distribution of the deposits, and the cheap importation of ore from other countries are the most important.

It is said that the most important deposits abroad are owned by one company, which controls domestic prices by reason of the relatively expensive domestic production and transportation. Production in the eastern portion of the United States, where the demand is greatest, ceased some years ago. On the Pacific coast the discovery of new and larger deposits gives promise of greater production with an increasing demand.

The improvement in the manufacture of ferrochrome by electric methods and the increased development of hydroelectric power has greatly cheapened the production of ferrochrome and has concentrated its manufacture in the hands of the company that holds the patents for the electric process. On June 20, 1911, United States Patent No. 995481 [1] was granted to E. F. Price, of Niagara Falls, N. Y., assignor to Central Trust Co., of New York, for producing ferrochromium by passing an electric current through a slag register adjacent to a charge containing carbon and combined iron and chromium to heat the charge to a temperature of reduction and by separating and maintaining the resulting alloy out of contact with the carbon in the charge by an intermediate layer of slag.

It is reported [2] that—

> An international ferrochrome syndicate which, though at the time only in course of formation, has played a most prominent part from the beginning of 1912 in regulating prices has now been definitely constituted, with a head office in Paris. It embraces all important European producers, but it has not been considered necessary to include the Americans, the reason being that the whole of the American output is absorbed by inland consumers, while, on the other hand, the tariff prevents imports from Europe.

The effect of this is to leave the domestic field for ferrochrome free to the domestic producers of this alloy.

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[1] Chem. Abstracts, Am. Chem. Soc., vol. 5, 1911, p. 2617.
[2] Min. Jour., London, Nov. 2, 1912, p. 1079.

PLATINUM AND ALLIED METALS.

By David T. Day.

PLATINUM.

DOMESTIC PRODUCTION.

CRUDE PLATINUM.

The high price of platinum encouraged prospecting in the United States during 1912, but did not greatly increase the production of crude metal, which amounted to 721 ounces as compared to 628 ounces in 1911. With the exception of a small yield from the New Rambler copper mines of the Douglas (Holmes) district, in Albany County, Wyo., the entire domestic production came from California and Oregon. The greater part of the California platinum was obtained as a by-product in gold dredging in Butte, Yuba, Sacramento, and Calaveras counties. The other placer operations of various kinds, especially in the northwest corner of the State, yielded the usual small quantity of platinum as a by-product. In Oregon the quantity recovered declined to 39 ounces. Nevertheless, the high prices stimulated the installation of modern machinery on the Oregon coast, and there is a prospect of a considerably increased production in 1913. A concentration table was installed near the mouth of Coquille River and another near Port Orford.

In 1912 a centrifugal machine was being operated on a small rich strip of beach near Coos Head, Oreg. The machine is an inverted cone lined with carpet and made to revolve rapidly so as to throw the gold and platinum outward and upward. On the ocean beach at Whiskey Run, Coos County, a large dredge has been mounted on four iron rollers, 8 feet in diameter and 4 feet thick, so that it can be quickly shifted from low tide to high-water mark, and even into the gulch back from the ocean, where dredging can be carried on during storms. It is planned to concentrate the sand partly on the dredge and to finish it up on shaking tables, of which two are now installed. At Bullard's mine, near Whiskey Run, a new amalgamator is being installed to collect both platinum and gold.

In Curry County, Oreg., two companies are developing the old beaches on upper Sixes River, using a patent concentrating device. One mile south of Cape Blanco two beach mines are in operation. The sand is collected by power scrapers holding about 1 cubic yard each, and after preliminary concentration the sands will be cleaned up on tables.

At Gold Beach, Curry County, Oreg., on the south side of the mouth of Rogue River, an ingenious concentrating device has been

installed which is claimed to have given good results with the exceptionally fine gold on Snake River. The machine consists of a wooden box with a trough at the bottom. A jig impulse is given to water in one side of the box, with the effect of keeping sand agitated in the other half, so that platinum and gold fall to the bottom. Some tons of concentrates have been collected. Experiments are still being conducted as to the most efficient method of cleaning up these concentrates.

Three miles south of Crescent City, Cal., a large concentrator has been erected on a tract of 135 acres of beach protected by sand dunes from the ocean. The sand is lifted by a hydraulic injector to riffles made of a patented alloy. The concentrates are cleaned up on similar riffles, which are subjected to an alternating current.

It is interesting to note that while the proportion of platinum to gold, where it occurs in the beach sands, varies from one-twentieth to one-half, and occasionally is even greater, the larger part of the platinum product came from dredge mining on Feather and Yuba rivers, Cal. On Feather River the dredges did not yield more than 1 part of platinum to 1,000 parts of gold, and on the Yuba the proportion of platinum is far less—certainly not more than 1 part of platinum to 3,000 of gold, and probably less. This speaks well for the efficiency of the methods of cleaning up in dredge work.

REFINED PLATINUM.

The United States supply comes chiefly from the unmanufactured and manufactured platinum imported indirectly from Russia. In addition, 45,280 ounces of platinum sand were imported into the United States, which, by the usual estimate of 80 per cent fine metal, would yield 36,224 ounces of refined platinum. It is estimated that the fine metal in the platinum sand produced in the United States would be 70 per cent, or 505 ounces. In all 36,729 ounces of fine platinum would probably be the contribution from foreign and domestic platinum sand. Another considerable source of platinum supply in the United States comes from the refining of imported and domestic gold and copper bullion, and from this source 1,300 ounces of platinum were obtained in 1912. It is not possible to determine the proportion of this platinum which came from domestic sources, but it probably was not more than 500 ounces. In all, the refined platinum produced in domestic refineries amounted to approximately 38,029 fine ounces, valued at $1,732,221, as compared with 29,140 fine ounces similarly obtained in 1911.

Much of the platinum obtained from copper bullion originated in the mines at Sudbury, in Ontario, Canada, but during 1912 materials classed as copper-platinum-palladium concentrates continued to be shipped from the New Rambler mine in Wyoming. The concentration plant established at that point makes it probable that this region will become a small but regular contributor. This mine and the platinum localities in general in the United States were described in the report of this series for 1911 by Waldemar Lindgren.

In the foothills of the Whitepine Mountains, Nev., near Illipah, in T. 17 N., R. 59 E, Mount Diablo meridian, 30 miles northwest of Ely, is a deposit of black sand from 500 to 1,000 feet in width and extending southwest from Illipah for 4 or 5 miles. Samples of the sand and

rocker concentrates reported to contain platinum were collected by a representative of the United States Geological Survey, and showed no platinum content on analysis by Ledoux & Co., of New York.

Production of refined platinum from domestic sources, 1903–1912, in troy ounces.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	110	$2,080	1908	750	$14,250
1904	200	4,160	1909	638	15,950
905	318	5,320	1910	773	25,277
1906	1,439	45,189	1911	940	40,890
1907	357	10,589	1912	1,005	45,778

PRICES.

The following table gives the prices of ingot platinum per troy ounce at New York, by months, for the calendar years 1908–1912:

Prices of ingot platinum per troy ounce on the New York market,[1] 1908–1912, by months.

1908.

January	$22.30	July	$19.60
February	22.10	August	18.20
March	21.80	September	18.60
April	21.75	October	21.15
May	21.35	November	24.50
June	19.85	December	24.10

1909.

January	$24.25	July	$22.50
February	24.50	August	22.00
March	23.75	September	25.50
April	24.00	October	28.00
May	23.50	November	29.25
June	23.00	December	29.50

1910.

January	$29.00	July	$33.00
February	28.75	August	33.00
March	29.13	September	33.63
April	29.25	October	37.50
May	29.55	November	39.44
June	31.38	December	38.75

1911.

January	$39.03	July	$42.98
February	39.35	August	44.35
March	41.02	September	45.32
April	41.33	October	46.22
May	48.85	November	46.10
June	42.86	December	46.05

1912.

January	$46.00	July	$45.50
February	45.63	August	45.50
March	45.50	September	45.50
April	45.50	October	45.50
May	45.50	November	45.50
June	45.50	December	45.50

[1] Eng. and Min. Jour., New York.

IMPORTS AND EXPORTS.

Platinum imported and entered for consumption in the United States 1903–1912.

Year.	Platinum ore or crude platinum, and unmanufactured products, ingots, bars, sheets, and wire.		Manufactured products, including vases, retorts, etc.	Total.
	Quantity.	Value.	Value.	Value.
	Troy ounces.			
1903	92,808	$1,920,044	$135,889	$2,055,933
1904				1,879,155
1905	93,912	1,985,107	188,156	2,173,263
1906	137,928	3,601,120	187,639	3,788,759
1907	74,292	2,508,991	175,651	2,684,642
1908	50,844	1,095,754	134,119	1,229,873
1909	118,853	2,557,596	416,352	2,973,948
1910	118,280	3,320,699	333,965	3,654,664
1911	[a] 122,751	[b] 4,723,489	142,718	4,866,207
1912	[a] 104,806	[b] 4,334,563	169,119	4,503,682

[a] Includes in 1911, 34,412 troy ounces of platinum ore or crude platinum and 88,339 troy ounces of unmanufactured products, ingots, bars, sheets, and wire; in 1912, 45,280 troy ounces of platinum ore or crude platinum, and 59,526 troy ounces of ingots, bars, plates, sheets, and wire, sponge or scrap.

[b] The value of platinum ore or crude platinum in 1911, was $1,278,239 and of unmanufactured products, ingots, bars, sheets, and wire, $3,445,250; in 1912, the value of platinum ore or crude platinum was $1,781,585, and of ingots, bars, plates, sheets, and wire, sponge or scrap, $2,552,978.

No exports of platinum are reported for the calendar year 1912.

WORLD'S PRODUCTION.

The world's output of crude platinum, 1910–1912, is given approximately in the following table:

World's production of crude platinum in 1910–1912, by countries, in troy ounces.

Country.	1910	1911	1912
Russia	[a] 275,000	[a] 300,000	[a] 300,000
Canada	[a] 30	[a] 30	[b] 30
New South Wales	332	470	[a] 500
Colombia	10,000	[a] 12,000	[a] 12,000
United States, domestic crude	390	628	721
United States, from foreign and domestic matte and bullion	[c] 1,000	[c] 1,200	[c] 1,300
Borneo and Sumatra and other [d]	[a] 209		[a] 200
Total	286,961	314,328	314,751

[a] Estimated.
[b] In addition to platinum contained in matte and bullion refined in the United States.
[c] Refined.
[d] Includes small production in Madagascar.

FOREIGN PRODUCTION.

RUSSIA.

The platinum industry was unusually active in Russia, owing to high prices. The effort which is being made to make the platinum industry a Government monopoly includes the project of a Government refinery. There is no prospect, however, for the completion of this plan for at least several years.

Production of platinum in Russia, in fine ounces.

Year.	Official.	Estimated total.
1900	163,060	212,500
1901	203,057	315,200
1902	197,024	300,000
1903	192,976	226,000
1904	161,950	290,120
1905	167,950	200,450
1906	185,792	210,318
1907	172,752	310,000
1908	156,792	250,000
1909	164,118	264,000
1910	175,716	275,000
1911	180,400	300,000
1912	177,375	300,000

Platinum and iridium have been found in an appreciable quantity in gold placers on the Russian border of Mongolia, and although no definite production from this source can be given, it is to be supposed that rich platinum and iridium placers will be developed in that region.

BRITISH COLUMBIA.

Under the stimulus of higher prices prospecting is under way in the Tulameen district, near Princeton, British Columbia, considerable proportions of platinum having been found in the placer gold of Granite Creek. The region was well described in Mineral Resources for 1911, and in the British Mining Journal of March 1, 1913.

The report for 1911 called attention to a reported find of platinum in certain dikes in the vicinity of Nelson, British Columbia. Since that time the provincial mineralogist has sampled these deposits and caused assays to be made by seven different authorities. As the result of this work it is evident that the claims of platinum in these deposits can not be substantiated.

OTHER PLATINUM METALS.

Palladium.—The uses, production, and imports of palladium were discussed in the report on platinum and allied metals in this series for 1911. In this it appeared that the estimated total production of palladium in the United States for 1911 was 2,390 ounces, partly from domestic and partly from imported sources. Considerable palladium accompanies the sperrylite obtained from the Sudbury copper mines in Ontario, Canada. Ruthenium is also found in this copper ore. Palladium also occurs with the platinum in the Rambler district of Wyoming.

The average price quoted for palladium was $55 per troy ounce. The Bureau of Foreign and Domestic Commerce reports the importation of 4,967 ounces of palladium in the calendar year 1912, valued at $213,397, compared with 1,218 troy ounces in 1911, valued at $56,307.

Iridium.—Iridium is the highest-priced metal of the platinum group. It averaged $65 per ounce during 1912, and the price is likely to rise on account of its increasing use for hardening platinum. It is probable that the supply may be somewhat extended in 1913 and subsequent years by increased beach mining on the Oregon coast, where iridosmine forms an unusually large proportion of the platinum sand.

CADMIUM.

By C. E. Siebenthal.

INTRODUCTION.

A brief account of the production, resources, metallurgy, and uses of cadmium was given as a chapter in Mineral Resources for 1908, and the reader is referred to that paper for further information.

The chief output of cadmium comes from the zinc-producing regions of Silesia, where it is recovered as a by-product in the distillation of zinc. Recently in England a little cadmium has been recovered in the purification of the solution of zinc sulphate in the manufacture of lithopone, and the same has been done in the United States for several years.

PRODUCTION.

Cadmium in metallic form has been recovered in the United States since 1907 by a single producer and since the latter part of 1910 by two producers. A considerable quantity of the pigment, cadmium sulphide, was also produced in 1912. No authoritative statement of the method of recovering metallic cadmium has yet been made. The metallurgical method employed abroad has generally been fractional distillation of zinc ores. Cadmium has also been recovered as a by-product in the manufacture of lithopone, as noted above. Among the possible sources of cadmium in a general chemical works would be the slime left in the production of zinc chloride from zinc scrap, skimmings, etc., or from low-grade roasted zinc ores. As dilute hydrochloric acid dissolves zinc in preference to cadmium, the cadmium content of the zinc scrap, skimmings, etc., is left behind in the slimes. From these slimes the cadmium may be recovered by distillation, by electrolysis, or by purely chemical methods.

Bain [1] noted the presence of cadmium in the zinc ores of the Leadville and Kokomo districts of Colorado, and Guyard [2] gives analyses of flue, chamber, and bag-house dust from Leadville, which show small percentages of cadmium in each. At the time Guyard's analyses were made the ores being smelted at Leadville were mostly carbonates, with little or no sulphides and only a trace of zinc. In the extensive zinc-lead sulphide deposits developed in later years the cadmium content, as shown by Bain, is much higher, so that the bag-house dust from Leadville ores must now show considerably higher proportions of cadmium. In 1908, W. R. Ingalls stated [3]

[1] Bain, H. F., Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 384.
[2] Guyard, Anthony, Geology and mining industry of Leadville, Colo.: Mon. U. S. Geol. Survey, vol. 12, 1886, Appendix C, pp. 712, 715, 717.
[3] Mineral Industry, 1907, p. 126.

that noteworthy quantities of cadmium occur in "fume" from lead smelting furnaces collected by bag filtration in Colorado, and that the utilization of this material as a source of cadmium had been considered, though negatived on account of lack of market for the metal.

In smelting such ores the cadmium will distill over from the blast furnaces to the bag house, where it will be caught with arsenic, lead, and antimony. When the burnt fume from the bag house is charged back into the blast furnaces most of the lead and antimony will be recovered in metallic form, but the arsenic and cadmium will again go over to the bag house. In time the fume will be very much enriched in cadmium and arsenic. The difference in temperature at which arsenic and cadmium volatilize allows an easy separation of these metals, and after separation the cadmium residue can be reduced to metallic form without difficulty. The cadmium may be recovered by distillation or by an electrolytic process.

Inasmuch as the production is limited to two firms, the quantity and value of the output can not be given. The local production in 1907 was nearly sufficient to supply the domestic demand—a fact shown by the small imports for that year—but the next year the quantity of cadmium imported was about doubled, and in 1909–1912 the imports of cadmium were back at the old figures which obtained before the beginning of the production of cadmium in the United States. The domestic production nevertheless was considerably larger in 1912 than in any previous year.

PRODUCTION IN GERMANY.

The following table gives the production of cadmium in Upper Silesia from 1882 to 1912, inclusive:

Quantity and value of cadmium produced in Germany, 1882–1912.[a]

Year.	Quantity.	Value	Average price per pound.	Year.	Quantity.	Value.	Average price per pound.
	Pounds.				*Pounds.*		
1882	7,762			1898	32,954	$29,666.76	$0.90
1883	5,333			1899	21,693	15,544.26	.72
1884	6,118			1900	29,835	19,524.81	.65
1885	7,222			1901	28,977	19,754.71	.68
1886	10,944	$8,710.56	$0.80	1902	27,833	15,132.00	.54
1887	16,140	11,542.29	.72	1903	36,519	19,242.06	.53
1888	10,573	5,439.49	.51	1904	55,655	32,882.32	.59
1889	11,327	4,621.71	.41	1905	54,163	35,240.18	.65
1890	9,167	3,477.18	.38	1906	47,368	36,083.89	.76
1891	6,281	2,423.32	.39	1907	72,639	60,757.35	.84
1892	7,055	2,713.20	.38	1908	72,741	48,590.21	.67
1893	11,651	5,198.87	.45	1909	81,982	46,777.16	.57
1894	15,095	8,393.31	.56	1910	90,516	39,309.51	.43
1895	15,095	9,052.04	.60	1911	93,861	53,372.45	.57
1 96	23,514	19,453.64	.83	1912	94,262	63,507.26	.67
1897	34,231	42,037.23	1.23				

a Recalculated to pounds and dollars from Statistik des Oberschlesischen Berg- und Hüttenmännischen Vereins, as quoted by Jensch, from Vierteljahreshefte zur Statistik des Deutschen Reichs and from Statistisches Jahrbuch für den Preussischen Staat.

IMPORTS.

Cadmium is imported into the United States as metallic stick cadmium and as the pigment, cadmium sulphide (CdS), known as

"cadmium yellow." The former is free of duty; the latter is dutiable at 30 per cent ad valorem. The value of the imports for consumption of metallic cadmium for 1903 to 1912, inclusive, is given in the table below, which is taken from the records of the Bureau of Foreign and Domestic Commerce. The quantities are not there recorded previous to July, 1909, and for the period preceding that time they have been computed by dividing the values of the imports by the average price of cadium for the corresponding year in Germany, from which country the cadmium was imported. The quantity of cadmium imported as a pigment and the value thereof are not kept separately by the Bureau of Foreign and Domestic Commerce.

Cadmium imported for consumption into the United States, 1903–1912, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	[a] 8,679	$4,565	1909 first half	[a] 6,659	$4,559
1904	[a] 7,655	4,524	1909 second half	2,203	
1905	[a] 8,138	5,298	1910	4,060	2,295
1906	[a] 13,808	10,522	1911	5,367	3,870
1907	[a] 1,953	1,633	1912	5,250	3,764
1908	[a] 3,567	2,390			

[a] Prior to July, 1909, the quantities are computed as noted above.

PRICES.

The domestic quotations on cadmium in 1912, as reported in the Engineering and Mining Journal, were stationary at 75 cents per pound for three-fourths of the year. For the remainder of the year the price was 80 cents per pound. The average price for the year, based on sales, was a little more than 75 cents per pound.

According to Paul Speier, of Breslau, Germany, the price of 99½ per cent cadmium sticks in 1912 fluctuated between 720 marks and 750 marks per 100 kilograms (91 cents to 95 cents per pound) f. o. b. cars at the works. The variation related to quantity and delivery, as the demand was even throughout the year.

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